Effects of Crumbrubber In Bituminous Mix

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Abstract- *The increasing growth rate of vehicles on road is a sign of an economic developing country. India is 2nd fast growing automobile industry. As vehicles are increasing, traffic intensity increases and as a result waste tires also increases. These waste creates problems like environmental pollution, landfill space and health hazards. This technical brief purely concentrate on crumb rubber as a replacement to the total weight of bitumen. Generally the life span for all highways and urban road is 10-20 years. But unfortunately damages on pavements have not stopped before reaching the maximum design period. Heavy traffic loading is major factor for this distress. Hence, use of crumb rubber in road construction has better skid resistance and crack resistance. The study involves physical test such as softening point test, ductility test to determine physical properties of bitumen and crumb rubber.*

Keywords- Bitumen, Crumb rubber, Marshall test, Mix Design.

I. INTRODUCTION

In India, approximately 15 million waste tires are generated annually. Not only are these tire mounds eyesores, they are also environmental and health hazards. Hazardous are tire fires, which pollute the air with large quantities of carbon smoke, hydro-carbons and residues. currently, the only large scale methods to use waste tires are through burning for electric power generation. Production of cement in cement kilns, energy to run pulp and paper mills, and recycling at tires to energy facilities.

In 1990, the Environmental Protection Agency (EPA) estimated that out of the 242 million waste tires generated that year, 78% of the tires were either stockpiled, a land filled or illegally damped. While some states burn waste tires this is only a temporary solution because of the tires, in many cases, tend to float back up to the surface. Land filling waste tires has also become more and more expensive as landfill space has decreased.

Asphalt acting as a binder for aggregate is a very important ingredient affecting the life cycle and travel comfort on road. It has been established fact that normal bituminous course cannot cope up with following problems:

1. Increasing traffic on road / overloading of vehicles leading to undulations, rutting, cracking, deformation and shortening of the life of asphaltic pavement.
2. High range of temperatures causing pavement to become softer in summer and brittle in winter.
3. Rain water causing extensive stripping problems in asphaltic pavement.

To overcome the above problems in the entire world it has become a regular practice to use modifier as additives to strengthen the asphalt for making longer lasting asphalt mixes. This has been a very important development in the last 3 decades and has led not only to huge saving by delaying a maintenance cycles of the road but also its importance has been felt in countries where aggregates and asphalt in short supply.

Natural asphalt is a naturally occurring hydrocarbon mineral that is high in asphaltense and high in the nitrogen when crumb rubber added to asphalt it dramatically increases the asphalt's viscosity, lowering penetration while increasing the softening point. The chemically treated crumb rubber besides have been designed to rapidly blend into asphalt. The addition of rubber gives the additional binding strength, increasing elasticity and softening point of the asphalt. Carbon present in rubber acts as an anti-oxidant and prevents asphalts from ageing and oxidization.

II. IDENTIFY , RESEARCH AND COLLECT IDEA

Rubberized bitumen is being used in USA from 1960. Currently Texas and California using 2 million tons of rubberized bitumen is very popular in Australia for cheap sealing wearing course sand structure layer.

One application was introduced by two Swedish companies which produced a surface asphalt mixer with the addition of a small quantity of rubber from discarded tyres as a substitute for a part of the aggregate in the mixer, in order to obtain asphalt mixer with improved resistance to studded tires is known as "**dry process"**. In the same period Charles McDonalds, a materials engineer of the city of Phoenix in

Arizona (USA) was the first to find that after thoroughly mixing crumbs with bitumen and allowing it to react for a period of 45 min to an hour, this material captured beneficial engineering characteristics of both base ingredients. He called asphalt rubber and the technology is well known as the "**wet process".**

Nowadays, these rubberized bitumen materials, obtained through the wet process, have spread worldwide as solution for different quality problems (asphalt binder, pavement, stress absorbing lays and inlayers, roofing materials, etc.) with much different evidence of success demonstrated by roads built in last 30 years.

III. MAIN MATERIAL IN CONSTRUCTION OF ROAD

Bitumen: Bitumen is a black, highly viscous and very sticky liquid or semi-solid, found in some natural deposits. It is also the byproducts of fractional distillation of crumb petroleum. Generally in India bitumen use in road construction of flexible pavement is grade 60/70 or 80/100 penetration grade.

BITUMEN

Crumb rubber: The major component of crumb rubber modifier (CRM) is scrap tire rubber which is primarily natural and synthetic rubber and carbon black, automobile tires have more synthetic rubber then truck tire. Truck tires have decreased the difference in chemical composition between the types of tire rubber. The average car tire contains 10 types of synthetic rubber 4 types of natural rubber, 4 types of carbon black, steel cord, bead wire, and 40 kinds of chemical, waxes, oils, pigments, etc.

CRUMB RUBBER

Aim and objectives:

Main objective is to use rubber waste and recycle it again and achieve maximum strength of road.

Less effect due to rain and temperature. Also it saves bitumen hence, economy.

To compare the properties of normal bitumen with change in properties by using waste rubber in bitumen.

Advantages:

- Higher resistance to deformation at increased road temperature.
- Improved Adhesion and bonding.
- Higher softening point and Skid Resistance.
- Higher elongation and tensile strength.
- Higher elasticity.
- Less thermal sensitivity, cracks prevention.
- High resistance to moisture due to rain.
- Longer road pavement life and lesser maintenance.
- Economical benefits, as there is no need to replace pavement, there is no need for additional equipment use.

IV. METHODOLOGY

To identify the performance of modified asphalt with rubber waste compared to unmodified asphalt, laboratory experiments have to be done. All experiment were based on standard specification on ASTM and AASHTO.

Marshall test design (ASTM D 1559) is carried to determine optimum content of aggregate and bitumen mixture

Ductility and Softening point test are carried to know if modified binder is appropriate. Ductility test specifies stiffness and Softening test specifies phase where change in bitumen occur.

EXPERIMENTAL WORK AND ANALYSIS

Data analysis is done by comparing all the results. The comparisons were observed in terms of density, stability, flow, VTM, VFB and VMA. It ensures suitability of waste as modifier to bitumen.

- **SIEVE ANALYSIS AND AGGEREGATE DISRTIBUTION**

All aggregates are sieved to sizes according to specification. Hot asphalt mix require particles of aggregates to be in range of sizes.

Size of aggregate		Length gauge	Weight of fraction passing of at least 200 pieces in gm (Wi)	Weight of aggregate in each fraction retained on length gauge gm (Xi)
Passing through IS sieve (mm)	Retained on IS sieve (mm)			
63	50	-	-	-
50	40	81	-	-
40	25	58.50	-	-
31.5	25	-	-	-
25	20	40.5	0.99	0.16
20	16	32.4	0.975	0.30
16	12.5	25.6	0.8	0.16
12.5	10	20.2	0.95	0.14
10	6.3	14.7	-	-

- **SOFTENING POINT TEST**

Softening point test was done for normal bitumen and modifier bitumen with 0%, 5%, 10%,15%,20% of crumb rubber content. From the result of the test, the softening point for normal bitumen was 48.5˚C. softening point increased with the increased amount of the crumb rubber added. This showed that the bitumen become less susceptible to temperature changes as the content of crumb rubber increased.

% of CRMB	Softening point test in ˚C
0%	48.5
5%	50.5
10%	55
15%	60
20%	63.5

- **BITUMEN DUCTILITY TEST**

Ductility test was done for normal bitumen and modified bitumen with 0%, 5%, 10%, 15% and 20% of crumb rubber content. The result shows that the rubber that was added will harden the bitumen. The bitumen become more viscous and hard, which would be useful to obtain stiffer bitumen.

% of CRMB	Ductility test in cm
0%	61.3
5%	42.8
10%	36.6
15%	25.5
20%	24.9

- **PENETRATION TEST**

Penetration Test were done for normal bitumen and modified bitumen with 0%, 5%, 10%, 15%, and 20% of rubber waste content. The result was shown in Table 5.2. From the result of the test, the penetration value for normal bitumen was 63 mm. Penetration value decreased with the increased amount of the rubber waste added. Lower penetration value making harder grade of asphalt, giving additional strength to the road and reduced water damage.

% of CRMB	Penetration test in mm
0%	63
5%	58
10%	55
15%	43
20%	30

- **MARSHALL TEST ANALYSIS**

Marshall stability test was done for normal bitumen and modified bitumen with 0%, 5%, 10%, 15% and 20% of crumb rubber content. crumb rubber gives satisfactory result by using it in 10% of proportion to replace the bitumen for marshall stability test of normal bitumen mix and by adding crumb rubber. Crumb rubber gives the marshall stability value of 2142.8kg by using 10% crumb rubber which is 1.07 times greater than the marshall stability value of normal bitumen.

Marshall test							
% of CRMB	Unit weight (kg/m³)	Stability (kg)	Flow (mm)	VTM (%)	VMA (%)	VFB (%)	Stiffness (kg/mm)
0%	2.30	1884.4	2.98	12.5	21045	42.3	726.69
5%	2.26	2032.0	2.75	13.21	22.04	44.5	1016
10%	2.211	2142.8	2.20	10.11	20.9	50.40	1025.2
15%	2.20	1819.3	2.74	10.90	22.50	52.3	663.98
20%	2.190	1205	3.30	19.89	22.60	55.8	365.15

- **Procedure:**

Measured totals approximately1200 grams of aggregates and filler are taken and heated to a temperature of 175C to 195C.The compaction mould assembly and rammer are cleaned and kept pre-heated to a temperature of 100C to 145C. the bitumen is heated to temperature of 121C to 138C and the required quantity of first trial percentage of bitumen is added to the heated aggregate and thoroughly mixed using a mechanical mixer or by hand mixing with trowel.Then the mix is heated and a temperature of 150C to 160C is maintained and then it is transferred into the pre-heated mould and compacted by giving 75 blows on each side.The specimens are cooled to room temperature and weighted in air then in water.Then are kept immersed under water in controlled water bath maintained at 60°±1oC for 30 to 40 min.the marshall stability value and flow are noted.

Sr. No.	Material	Content
1.	Bitumen	5%
2.	Aggregates	85%
3.	Crumb rubber	10% of bitumen content.

V. CONCLUSION

- Softening point test shows that softening point increased with the increased amount of crumb rubber added. This showed that the bitumen becomes less susceptible to temperature changes as the content of crumb rubber increased. Increasing of softening point, thereby giving it protection against hot climatic condition.
- Ductility test result shows that the crumb rubber will harden the bitumen. The bitumen becomes more viscous and harden, which would be useful to obtain stiffer bitumen asphalt.
- Penetration value decreased with the increased amount of the rubber waste added. Lower penetration value making harder grade of asphalt, giving additional strength to the road and reduces water damage.
- The biggest advantage of using rubberized bitumen is that the road life increases in comparison to the normal bitumen.
- Improve adhesion aggregates and binder there by giving better strength, stability and longer life.
- Optimum content of rubber is found to be 10% of total bitumen as maximum stability is achieved at that point.

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