Use of Tyre Rubber in Bituminious Concrete Mixes

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Abstract : **Tyre scrap are being generated in large volumes causing an enormous threat to the environment. To get rid of the negative effect of these scrap tyre depositions these tyre scraps can be used in many civil engineering works. It has been studied for more than 30 years that these can be used in civil engineering applications. The various processes where scrap tyres can be used and has been tested to be productive in safeguarding the environment and protecting natural resources including the manufacturing of cement, road construction and geotechnical works.**

Keywords – Tyre, Rubber, Concrete Mux.

I. INTRODUCTION

Tyre scrap fragments and their smaller parts such as crumb rubber, have been used in number of Civil Engineering applications. Tyre fragments which is harshly ripped into 2.5 to 30 cm pieces have been researched broadly as light-weight fill for embankments, retaining walls, drainage layers for roads and in septic tank leach fields. Some of the advantageous properties of tyre fragments include low density material, high bulk permeability, high thermal insulation, high resilience, and high bulk compressibility. Crumb rubber has been efficiently used as an substitute aggregate source in asphalt concrete and PCC. Sub grade Insulation for roads excess water is released when sub grade soils thaw in the spring. Laying down a 15 to 30 cm ripped tyre layer under the road averts the sub grade soils from freezing. The high permeability of tyre fragments let the water to drain below the roads, which in results preventing damage to road surfaces. From the last two decades, roads have worsen more due to increasing in traffic density, axle loading, and poor maintenance services. To reduce the vandalization of pavement surface, the standard bitumen needs to be enriched in view to performance associated properties, such as resistance to permanent deformation (rutting) and fatigue cracking. The alteration of bituminous binder has been examined over the past decades in order to upgrade road pavement properties. There are many refitting processes and accompaniment 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).

II. MATERIAL

Bituminous mixture is usually consists of aggregate and bitumen. The aggregates are usually grouped into coarse, fine and filler fractions on the basis of size of the particles. The following description is about the coarse aggregate, fine aggregate, mineral fillers and bitumen used in this study.

Aggregate: According to the Asphalt Institute the coarse aggregate for bitumen mix has been defined as the portion of the mixture which passes through 20mm and gets retained at 10mm.The coarse aggregate is basically basalt rock. It was crumbled manually and brought under the size of less than 20mm,after this the aggregates were then sieved by using I.S. standard sieves and discreted out in distinct fractions. Fine aggregate for bituminous mix has been defined as that portion of the mixture which passed from 10 mm and retained on 2.36 mm sieve according to the Asphalt Institute.

Bitumen: Roads have been constructed since ancient times and as the time goes on the materials which we used in ancient times also changed. In recent times we use bitumen materials to construct roads to make its surface smoother and flexible. Here we are going to use 60 -70 grade bitumen.

Crumb Rubber: Crumb rubber is a recycled rubber produced by shredding used tires. The increasing piles of tires are creating environmental concerns all over the world. Hydrocarbon binder Crumb Rubber Modified Bitumen (CRMB) is obtained by Dry and Wet process of crumb rubber with bitumen and specific admixtures.

III. METHODOLOGY

The materials which we used for this research work are aggregate, bitumen and tyre rubber scrap.The different tests have been done to know the different properties of materials which we used, after knowing the different properties of materials then different mixes of bitumen and crumb rubber with varying percentage by using wet process and dry process.

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LOS Angles Abrasion and Aggregate Crushing Test: This test is used for measuring the abrasion resistance of aggregates. The top layer of a pavement gets abraded due to the movement of tyres. A material which has high abrasion resistance has a long life. The LOS Angles Abrasion test was carried out in accordance with AASHTO-T96.

Strength of coarse aggregate is determined by the aggregate crushing test. Aggregates used are dry aggregates passing from 12.5mm IS sieve and retained on 10mm IS sieve. Aggregate crushing value less than 10% signifies a very strong aggregate while above 35% would normally regarded as weak aggregates.

Penetration Test: Hardness of bitumen is obtained by the penetration test. It measures the distance of standard blunt pointed needle will vertically penetrate a sample of materials at 27^0 C, the load being 100g and time of application of load being 5 seconds. The unit of penetration is 1/10mm.Thus 80/100 grade bitumen mean 8-10mm penetration. The bitumen test was carried out in accordance with AASHTO-T49.

MARSHAL STABILITY TEST: The mix design determines the optimum bitumen content for the evaluation of performance of bituminous mixed flow test and stability test are performed.The marshall stability and flow test provides the performance prediction measure for the marshall mix design method.

Stability is defined as maximum load carried by specimen at a standard temperature 60^0 C and with the loading rate of 50.8mm/minute. Stability is expressed in kg. Flow is measured as deformation in units of 0.25mm between as load and maximum load during stability test.Thus if deformation is 6mm, flow value is 24.

IV. RESULTS

Table No. 1: Bitumen Properties by different % of rubber

Properties	60 / 70 grade bitumen	Bitumen with rubber content %					
		5	10	15	20	25	30
Penetration value @ 25^0C, 5 Sec, 100 gm	65.6	59.3	56.3	45.6	35.3	27.2	21.6
Softening Point(^{0}C) @ ring ball test	57	62	62	65	72.5	77.5	83
Ductility test (cms)@ 27 ^{0}C, 5 cm/min	73	61	55	41.6	21.8	14.3	12.7
Viscosity test@ 27^0C(sec)	25.5	22	20	16.5	15	11	8.5
Specific Gravity	1.030	1.18	1.20	1.40	1.65	2.2	2.25

Table No 2 : Recommendations of IRC for modified blended bitumen

%of rubber	Wt.of sample (gm)		Bulk specific gravity (g/cc)	% air voids (Vv)	VMA	VFB	Marshall stability (kg)	Flow value (mm)
	Air	water						
0	1256	773	2.57	4.13	15.48	73.39	1190.57	3.2
5	1275	788	2.59	4.09	14.12	71.11	1050	3.0
10	1279	799	2.61	4.42	14.04	68.63	912.7	2.8
15	1269	791	2.64	4.37	12.63	65.29	843.7	3.5
20	1283	792	2.61	5.11	12.74	58.01	715.8	2.6
25	1271	790	2.64	5.06	10.80	53.27	652.8	2.8
30	1269	794	2.65	6.07	11.42	46.97	550.5	2.5

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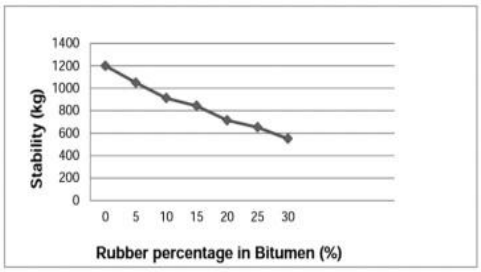
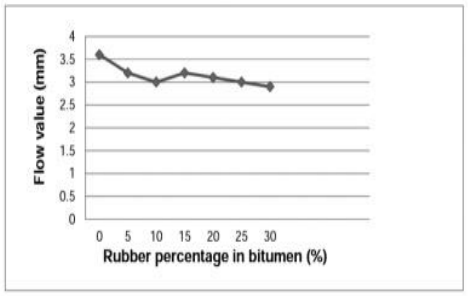
The values of Marshall Stability are consistent for all rubber percentage reading.

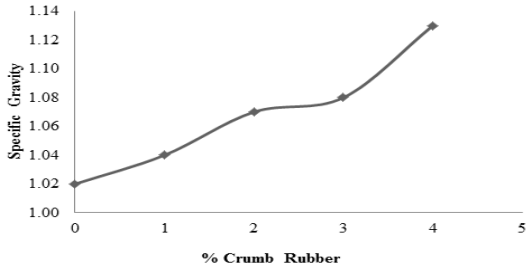


Graph 01: Rubber percentage in bituminous concrete vs marshall stability.

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

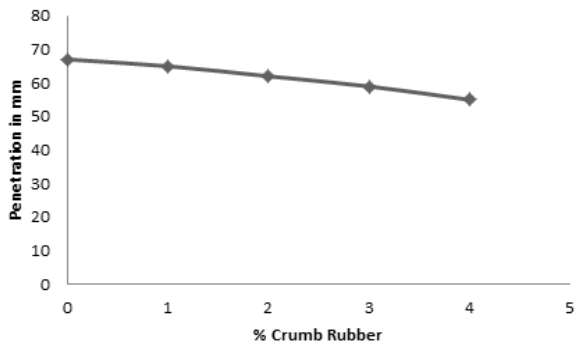


Graph 02:Rubber percentage in bituminous concrete vs flow value.



Graph No 3 Variation of specific gravity with addition of rubber waste

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.



Graph No 4: Variation of Penetration with addition of rubber waste

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

Table No 3: 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:12025	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 No: 4 Test results of aggregates

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 Elon-gation Index	IS:2386(1)	28%	30%max
Crushing test	IS:2386(4)	20%	45%

V. CONCLUSION

The basic property that we tested for VG-60 bitumen is in permissible limit.By adding 0-4% Crumb rubber in bitumen specific gravity, softening point, fire and flash point are increasing and ductility, penetration are decreasing. But up to 1% addition of crumb rubber obtain value are in limits. Stability and flow of bituminous mix are within limit up to 1% of crumb rubber. By substituting 5% aggregate of size passing 19mm and retained on 13.2mm by rubber aggregate obtained Marshall Stability and flow value are within optimum limit.

The flow accelerates as we increases rubber content for the different RPS and there is no set arrangement between RPS and flow,the percentage air voids increases as we increases rubber content for 4.75mm RPS and 2.36mm RPS. However, the same orientation is not correct for 0.600mm RPS.The VMA decreases as we increases the rubber

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content for 4.75mm RPS and 2.36mm RPS but for 0.600mm RPS where the VMA increases as we increases the rubber content. Overall the VMA increases as the RPS increases from 2.36mm to 4.75mm. As we increases the rubber percentage, the specific gravity decreases and there is no set model for RPS. Addition of tyre waste in rubber aggregate adjust the flexibility of surface layer.The deformation and thermal cracking are minimized in scorching temperature region.The basic property of rubber is sound absorbing, so by the use of tyre rubber the noise pollution of heavy traffic roads is controlled.The tyre rubber waste is used in road construction, so to upgrade the quality of road.Tyre rubber waste is used in different layer and on the top surface layer with bituminious mix in percentage (5,10,15) by replacing it which results in upgradation of properties of bitumen as well as aggregate and minimizes the pollution occurred due to tyre waste and also use of rubber waste is cost effective as compared to other material and using the rubber in bitumen, the strength of bitumen will also be increased.

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