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USE OF PLASTIC WASTE IN FLEXIBLE PAVEMENT CONSTRUCTION

G.H V Sai Simha[1], Lalit Kumar[2]
PG Student, Civil Department, Amity University, Haryana, India[1]
Assistant Professor, Civil Department, Amity University, Haryana, India[2]
manuharsha823@gmail.com[1], lkyadav@ggn.amity.edu[2]

Abstract: **Generally, the road network in India and abroad carries both the passenger and freight transport. India has a road network of over 54, 72, 144 kilo meters and it is the world's second largest network. Most of the investigations stated that in India due to the increase of traffic day by day the application of wheel loads on the flexible roads are very high. So, the stability of flexible pavement is decreasing due to wheel load and deformation of roads is getting increased day by day. To overcome this problem the properties of the bitumen on the roads should be improved by adding additives to the bitumen known as bitumen modifiers. In India, the majority of the plastic waste mainly consists of polyethylene, polypropylene and polyolefins. In this paper, the natural rubber is used as the modifier to convert the normal bitumen to modified bitumen, because of similar properties to that of plastic waste categorized under polyolefin. Marshal method of bituminous mix design was carried out for various percentages of natural rubber in bitumen and various different mix design characteristics has been determined.**

Keywords*: polyolefin, flexible roads construction, India*

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I INTRODUCTION

Plastic is any synthetic or semi synthetic organic polymer. It is made from a wide range of organic polymers such as polyethylene, Polyvinyl Chloride (PVC) etc. that can be molded into the shape while soft and then set into a rigid and slightly elastic form. Plastics are durable and degrade very slowly, the chemical bonds that make plastic durable make it equally resistant to natural process of degradation (Chavan, 2013). From the last two decades environmentalists are very much interested in developing the techniques for the management of solid waste generated through the day to day practices. The municipal solid waste contains mixture of biodegradable as well as non-biodegradable component. The non-bio degradable waste consists of plastic bottles, rubber, glass and metals like aluminium, iron etc. Today every sector starting from the agriculture to automobiles etc had been revolutionized by the plastic (Shweta N. Rokdey, 2015). The waste plastic is used as the stiffen binders for reducing the rutting, thermal cracking, stripping, cost of maintenance of pavement. It improves the fatigue resistance, bituminous pavement durability and provides clean environment. The majority of plastic waste is polyolefin which includes High Density Polyethylene (HDP), Linear Low Density Polyethylene (LLDP), Polypropylene (PP) and High Molecular Weight Polyethylene (HMWP). The density of HDP is greater than 940 kg/m^3 whereas the density of LLDPE is less than 965 kg/m^3.

The plastic shopping bags, tank and cutting boards etc. produces the High Density Plastic. The extensive use of LLDPE can found in agricultural use as well as industrial use. According to recent studies, every year totally 71% of non-bio degradable plastic waste is generated. Out of that 70%, of non-bio degradable plastic waste low density polyethylene (LPDE) is of 18%, high density polyethylene (HPDE) of 15%, poly vinyl chloride (PVC) of 15%, polypropylene (PP) of 13%, Polystyrene (PS) of 8% and polyethylene terephthalate (PET) of 2%. Beverage bottles, pipes, cable, milk bags represent HDPE (Jain & Swetha, 2014). They are tough, flexible and translucent. Trash bags, plastic bottles etc. are LDPE. They act as moisture proof. Sports goods, luggage, pipes etc. represents PVC. They are strong and clear. Battery cases, cap screws etc are part of PP. They are stiff and have resistance towards heat and chemicals. House wares, electronics etc represents PS. They are rigid and have good thermal properties. Soft drinks, detergent etc. represents

PET. They are very tough and are resistance towards shatter, gas permeation (S.S VERMA, 2008).

II SPECIFICATIONS FOR THE DBM

Table 1: Physical requirements of DBM

These specific limits are taken from the MORTH (MINISTRY OF ROAD TRANSPORT AND HIGHWAYS – SECTION 505)

S. NO	PROPERTIES	NORMAL BITUMEN	MODIFIED BITUMEN
1	STABILITY (KN)	9	12
2	DEFORMATION (mm)	2 – 4	3.5-5
3	% AIR VOIDS	3-5	3-5
4	% VMA (min)	12	13
5	% VFB	65-75	65-78

Table:2 GRADIATION TABLE (DENSE BITUMINOUS MECADAM)

These sizes of sieves and cumulative percentage by weight of total aggregate passing are considered from the MORTH (SECTION 505)

Tests conducted for bitumen	Normal bitumen (nb) (5%)	Nb+4% Natural rubber (nr)	Nb+5%(nr)	nb+6%(nr)
penetration test	66.66	77.46	76.74	79
ductility	70	57	54	51
softening point (^{0}c)	35	49	54	57

Is sieve (mm)	percentage weight of passing	percentage weight of retaining	percentage retained in each sieve	weight retained in each sieve(gm
45	100-100	0-0	0	0
37.5	100-95	0-5	2.5	27.7
26.5	93-63	7-37	19.5	234
13.2	75-55	25-45	13	156
4.75	54-38	46-62	19	228
2.36	42-28	58-72	11	132
0.3	21-7	79-93	21	252
0.075	8-2	92-98	9	108

Table 3: Tests conducted on bitumen.

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III METHODOLOGY

The 95% aggregates i.e. 1140 grams are sieved and taken in a separate pan. The 90 microns sieved 5% cement i.e. 60 grams is added to the aggregate mixture. The Aggregate mix in a pan is heated till 180° Celsius (C), at same time the plain bitumen is heated in other pan till 130° C. The bitumen grade considered is VG-20. Now the 4% of dry natural rubber powder is mixed with the bitumen and continue heating the bitumen until 130° C. After completion of heating 5% (60g) of modified bitumen is added in the heated aggregate mix and mix it for 150° C. Then apply the grease to the mould and fill the mould with that modified bituminous mix then manually start giving the 75 blows on top and bottom of the mould.

After keep the mould for 24 hours, then next day take the mould and find the specific gravity and note the diameter and thickness of the aggregate mould. Keep the modified bituminous mould in water bath at the temperature of 60 degrees. After note, the stability and flow of the bituminous mix by observing in marshal stability testing machine. Then repeat the experiment by doing 3 normal bituminous moulds without adding natural fiber and other 2 modified bituminous moulds by adding 5% & 6% of natural fiber.

IV TESTS & RESULTS

Tests conducted for aggregate

AGGREGATE IMPACT TEST: 14 % (<17%)

Tests conducted for bitumen

Penetration test

Ductility

Softening point

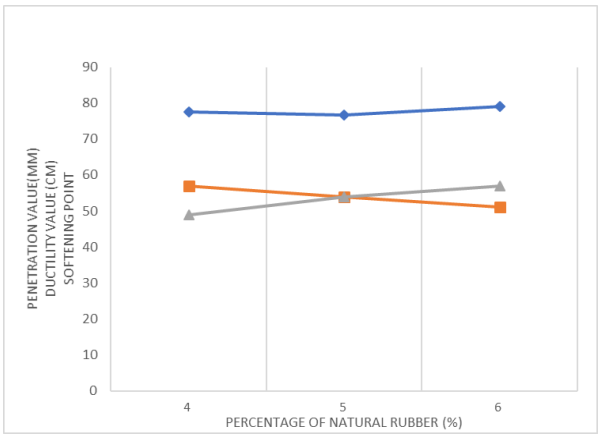

Figure 1: The relation graph between Percentage of natural rubber and penetration values, ductility, softening point

V MARSHAL STABILITY TEST

Table 4: Marshal Stability values

	Stability (kg)	flow (mm)	bulk density (gm/cc)	Volume of voids (v_v) (%)	VMA (%)	VFB (%)
normal bitumen (5%)	930.3	4.9	2.324	4.47	16	75
nb + 4%nr	980.5	4.26	2.32	3.72	15.52	76
nb + 5%nr	1170	4.51	2.33	3.41	15.21	77
nb + 6% nr	1162	4.32	2.35	3.54	15.49	77

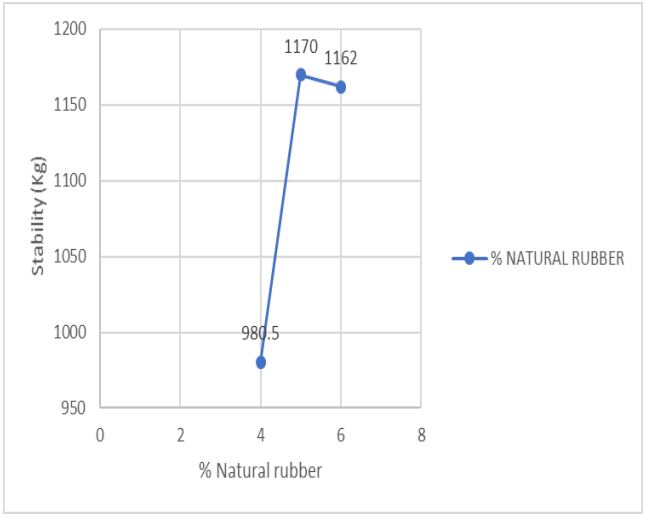

Figure 2: The graph between percentage of natural rubber used and stability

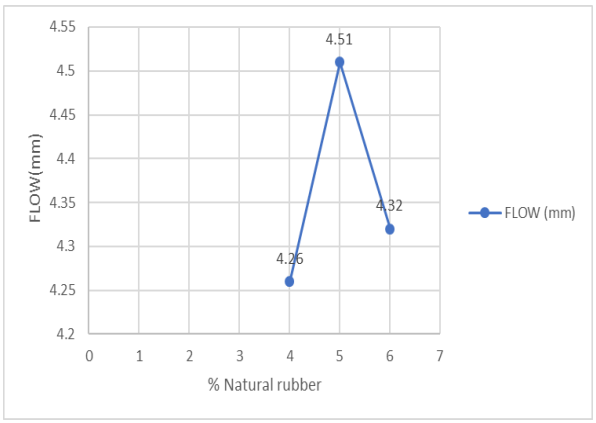

Figure 3: The graph between percentage of natural rubber used and flow

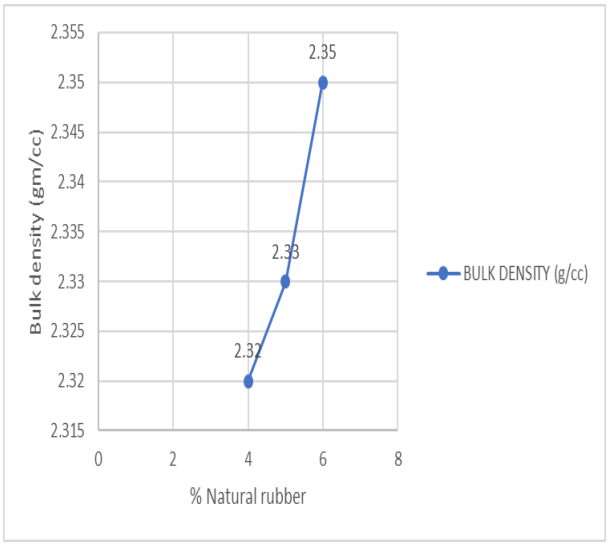

Figure 4: The graph between % Natural rubber and Bulk density (gm/cc)

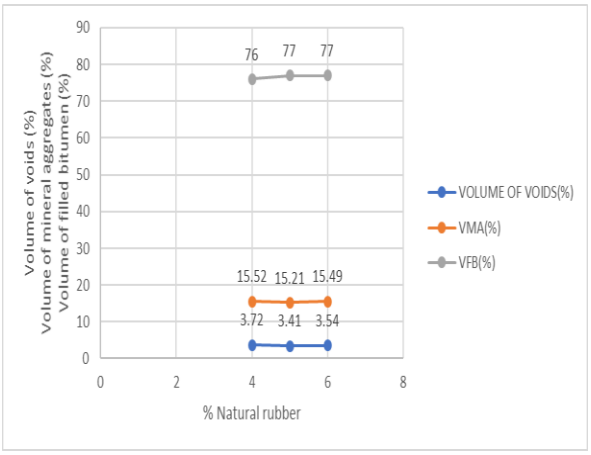

Figure 5: The graph between % Natural rubber and Volume of voids, VMA, VFB

VI CONCLUSION

The results of bitumen grade VG-20 is obtained from the experiment. Here, the penetration value for the normal bitumen is 66.66, when the natural rubber of the 4% is added to the bitumen, the penetration value is gradually increased, then suddenly it gets decreased when 5% of natural rubber is added, it means that bitumen is softened at 4% and becomes hard at 5%. From the ductility test, the values are gradually decreasing from the 4% to 6%. Rubber being a brittle material contributes in decreasing the ductility value although it is greater than minimum value specified in the code. Here all the ductility values are suitable because they are greater than 50. In the case of softening point, the values are gradually increasing; it means that all percentages are used for the binder contents. The stability value is gradually increased by adding the natural rubber 4%, 5% and decreased at 6% and it represents the optimization of strength of DBM mix. The deformation value is also decreased gradually by adding natural rubber. The bulk density is gradually increasing when the addition of natural rubber is increased in bitumen. In comparison with normal bituminous mix, the volumes of voids present in modified bituminous mix are less. The values of all other parameters are also in specified limits. After taking this results into consideration, finally this paper concludes that by adding natural rubber the serviceability of the road will gets better and also the resistance of the road towards the moisture is improved. The optimum quantity is 5% of natural rubber taking into consideration variation in every property of concrete.

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