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Waste Plastic and Crumb Rubber in Flexible Pavement

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Abstract

Use of waste plastic and natural crumb rubber in road is being increasingly encouraged to reduce environmental influence. The plastic waste measure in of solid waste is increasing due to increase in population and changes in life style. Similarly, tyres those fitted to motor vehicle, are manufactured from synthetic Stinker rubber. Disposal of both natural rubber and vehicle tyres is a serious problem. At the same time, constant increase in the number of vehicles accentuates on need of road with better caliber and production design. Hence, waste plastic and crumb rubber can be used to partially replace the conventional material along with bitumen to improve desired mechanical characteristics for particular road mix. In the present study, a comparison is carried out between use of waste plastic like LDPE and Rubber (1, 1.5,2,2.5%by weight of bitumen) in bitumen concrete mixture to analyze which has better power to modify bitumen to use it for road construction, giving the same strength.

Keywords: Aggregates; Bitumen; Crumb rubber; LDPE; Marshal Stability Test.

Introduction

Today, for most of the advance countries, flexible pavements are one of the important types of road construction. In recent times, it is been observed that due to raise in axel cargo and traffic intensity the efficiency of the bituminous binder is been reduced causing bleeding in hot circumstance, cracks in low temperature, rutting and pot holes. Disposal of a diverseness of plastic & pencil eraser wastes in an eco-friendly way is the substance area of today 's research. The waste plastic and the crumb rubber for the twist of flexible pavement material which would give a better solidity, resistance and strong, suit to the road as compared to the conventional rubber. As they are remarkably non-biodegradable thus can be used as a modifier in bitumen and aggregates to increase their strength.

Materials and methodology:

1. **Aggregates**: The natural totality again are classified as coarse aggregates lie of crushed rock aggregates or gravel and fine aggregates or sand.
2. **Bitumen:** Bitumen is used as binders in Pavements constructions. Optimum bitumen content considers by Marshall tests.

Table 1: Aggregate gradation for bituminous concrete pavement layers (BC)

Sieve size	Wt retained in (gm)	% wt retained	% cummlative retained	% wt passing
20	152	5.07	5.07	94.93
16	672	22.4	27.47	72.53
12.5	782	26.04	53.51	46.49
10	292	9.74	63.25	36.75
6.3	801	26.7	89.95	10.05
4.75	141	4.7	94.65	5.35
2.36	40.5	1.35	96	4
1.18	28	0.94	96.94	3.06
600	44.5	1.49	98.43	1.57
300	36	1.2	99.63	0.37
75	11	0.37	100	0

Table 2: marshal stability values of plain bitumen of penetration grade 80/100.

% bitumen	Gt, gm/cc	Stability value ,kg	Flow value in 0.25mm
4	2.55	1137	2.33
4.5	2.53	1676	2.43
5	2.51	1767	2.83
5.5	2.49	1394	3.03

Table 3: present study bitumen properties

SL no	Properties	Test methods	
		80/100	
1	Penetration(25° C,5 sec)	90	IS:1203-1978
2	Softening point (R & B), ° C	41	IS:1205-1978
3	Ductility @ 27° C,cm	75.5	IS:1208-1979
4	Specific gravity,gm/cc	1.02	IS:1202-1980

Plastic & Rubber Material:

LDPE (low density polyethylene)

Properties:

- Impact resistant from -40 C to 90 C
- Moisture resistance
- Good chemical resistance
- Food grades available
- Readily processed by all thermoplastic methods

a) Tests For Aggregate

Table 4: present study aggregates properties

SL .No	Tests on Aggregates	Test results obtained	Requirements of MORTH specifications
1	Crushing value (%)	24.8	-
2	Impact value(%)	20.8	Max 24%
3	Los Angeles abrasion values (%)	28.5	Max 30%
4	Water absorption(%)	0.25	Max 2 %
5	Specific gravity of coarse aggregates	2.72	2.5-3.0
6	Specific gravity of fine aggregates	2.76	2.5-3.0
7	Specific gravity of filler	2.5	2.5-3.0

b) Tests For Bitumen

Table 5: present study bitumen properties

SL no	Properties	Test methods	
		80/100	
1	Penetration(25° C,5 sec)	90	IS:1203-1978
2	Softening point (R & B), ° C	41	IS:1205-1978
3	Ductility @ 27° C,cm	75.5	IS:1208-1979
4	Specific gravity,gm/cc	1.02	IS:1202-1980

Using Marshall Method of bituminous Mix design, the Semi Dense Bituminous Concrete (SDBC) mix was qualified. Using conventional bitumen, SDBC was prepared, bitumen added with varying percentages of LDPE and bitumen added with varying percentages of Crumb Rubber. The details of the experimental programmed are as follows.

Marshal Stability testing machine

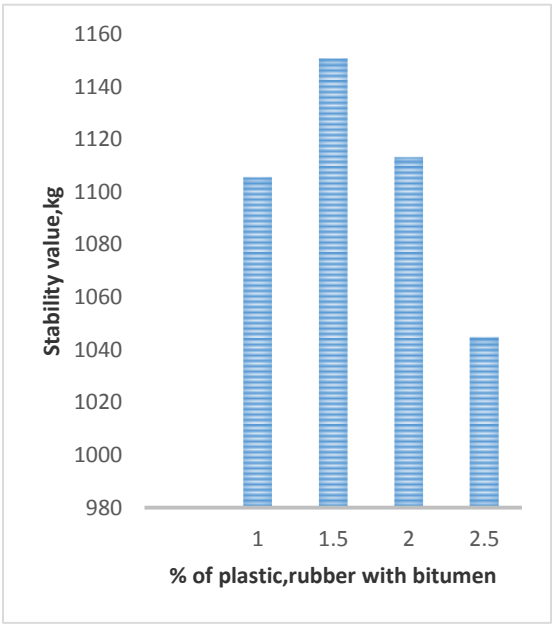
From graphical records, it is observed that with increase in bitumen concentration the George Marshall stability value increases up to a certain bitumen content & then it decreases. Thus the maximum stableness was obtained at 5 percent from % bitumen v/s stability graph. From above graph, bitumen content corresponding to maximum density is 5 %. From graphs, the bitumen content corresponding to 4% air voids was obtained as 4.9%. Hence the optimum binder content was calculated as 5.19 %. Voids filled with bitumen should be between 75-85. VFB was 77.32, at 5.1% bitumen by system of weights aggregate, which is satisfactory. Thus at optimum bitumen content and varying contents of modifiers, it was found that in both cases maximum stability was obtained at 5%. Thus the optimum modifier content was obtained as 5%.

From the above graphs it is observed that with increase in binder content,flow value also increases.

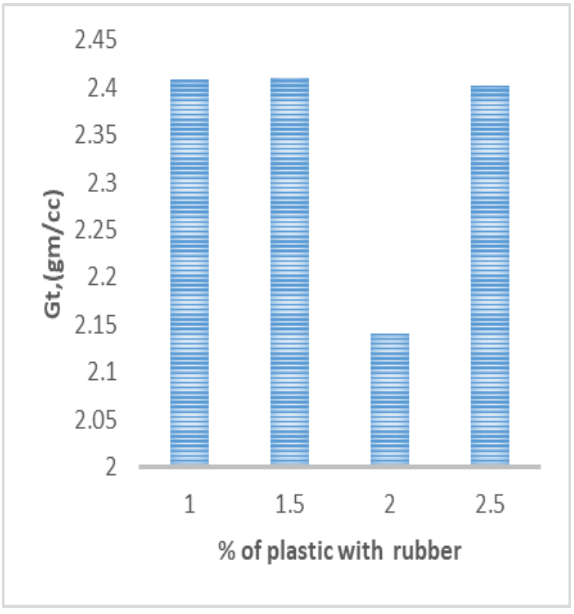
Table 6: marshal stability values for bc grade varying plastic with crumb rubber

% bitumen	Gt, gm/cc	Vv %	VFB,%	Stability value,kg	Flow value in 0.25mm
1	2.62	8.89	1.18	1105.5	8.2
1.5	2.61	7.66	1.76	1150.63	8.51
2	2.60	7.7	2.33	1113.07	9.06
2.5	2.6	7.62	2.9	1044.79	9.13

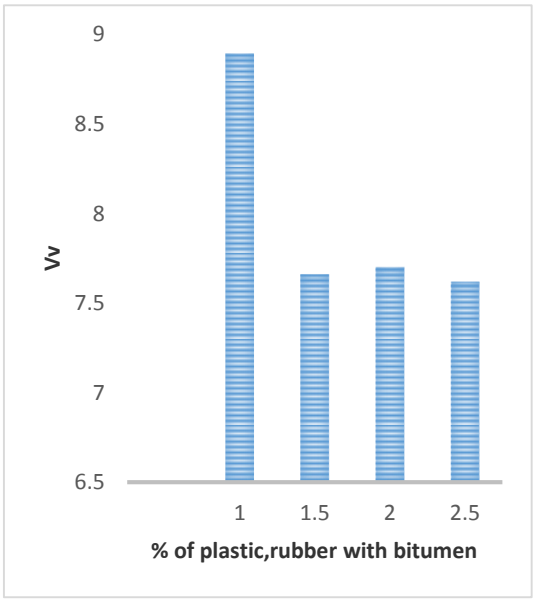
Comparison Between Stability & Plastic with Crumb Rubber



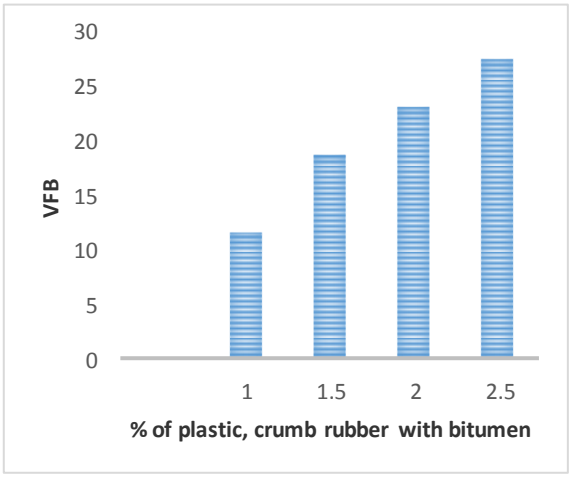
Comparison Between Bulk Density & Plastic with Rubber



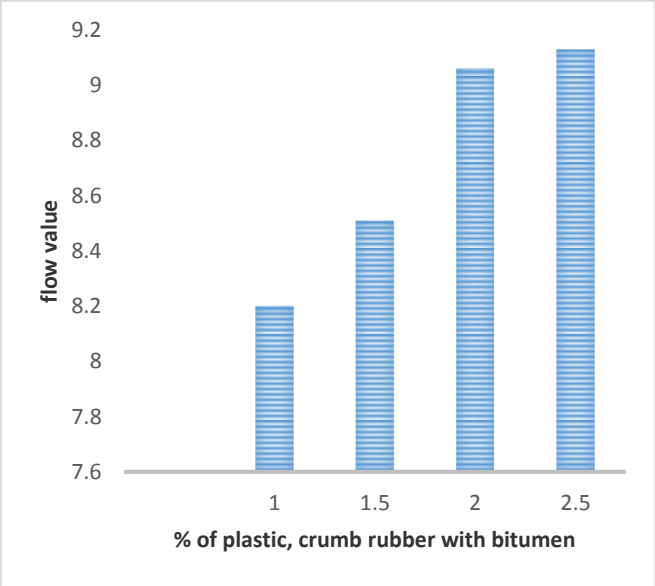
Comparison Between Voids Ratio & Plastic with Rubber



Comparison Between Voids Filled With Bitumen (VFB) & Plastic with crumb rubber



Comparison Between Flow Value & Plastic with crumb Rubber



Conclusions

The following conclusions are drawn based on the experimental investigation:

• OBC was obtained as 5%, by carrying out Marshall Test for control mix sample which was prepared by adding 4%, 4.5 %, 5 %, 5.5 % bitumen by weight of aggregate to form BC mix.

• Keeping constant OBC 5%, accession of LDPE and Stinkpot Rubber in 1%, 1.5%, two % & 2.5% to BC mix sampling.

• . LDPE can be regarded as the best modifier among three.

Since the Marshall stableness is higher in case of LDPE 1963 kg @ 2% when compared to Crumb Rubber and LDPE with crumb rubber

• Thus, it can be concluded from the report that the qualifier when used in 2% by weight of bitumen can improve the stability of pavement, best among them being LDPE.

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