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Study the properties of the bitumen concrete using waste plastic and Crumb Rubber

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Abstract :-The populace development, industrialization, consumerism and innovation improvement have prompted wild accumulation of waste. Plastic and elastic rubbers easy to use yet not eco-biodegradable. appropriate waste switch is of first rate importance in both rural and metropolitan regions. Waste plastic and waste tyre elastic rubber(crumb rubber) can used in bituminous blends have demonstrated. That the properties of blend are enhanced disposal problems are also solved to a degree. It is seeing that these aren't disposal scientifically and possibility to create ground and water contamination. These waste plastic and waste elastic rubber somewhat supplanted the ordinary material to enhance wanted mechanical attributes of bitumen blend. Waste plastic and waste rubber changed bitumen blend display higher binding property compare to the traditional blend. Strength, ductility, water tightness, aggregates properties get changed when the replacement of traditional ingredient done with these waste materials.

Key Words:- Ductility test apparatus, Bitumen, Waste rubber and Waste plastic of desired fineness, Marshall stability and flow value test apparatus.

I. INTRODUCTION

The polymer (rubber and plastic) altered bitumen demonstrate properties for road development and plastic waste can discover its utilization in this procedure and this can help taking care of the contamination problem. The better adhesive property of waste plastic is in its liquid state has helped in discovering a efficient way for safe disposal of waste plastic.
Due to its low price, clean production and impervious to water, plastics and rubbers are utilized in production huge variety of products. Efficient disposal of waste plastic and waste rubber in an green way is now a day become a greater importance of topic for research.
The plastic waste and waste crumb rubber used as the road construction material give better strength, durability, wearing resistance and good stability or better density to the road compared to the traditional materials. Rubber are non-biodegradable in nature thus pollute the environment but it can be used as a modifier in bitumen and aggregate for their properties improvement.

Material introduction:-

Course aggregates: - These are the crushed rock materials also called gravel. For making of bitumen mix we use course aggregates of passing through 4.75 mm size sieve and retained over 2.36 mm sieve.

Fine aggregates: - These are also crushed but the degree of fineness is more compare to the course aggregates for making bitumen mix we use the fine aggregates of passing through 2.36 mm sieve and retained on 75 micron sieve.

Bitumen: - Presently different grades of bitumen's are available. All the bitumen is derived from the factored distillation of crude oil. Bitumen is dark black in colour and remains semi solid state naturally.

Waste plastic: - Waste plastics now a day become vary commonly available material. The waste plastic may be any form like PET bottles of polyethylene carry bags etc. We use shredded plastic bags of size 4.75mm to 2.36 mm.

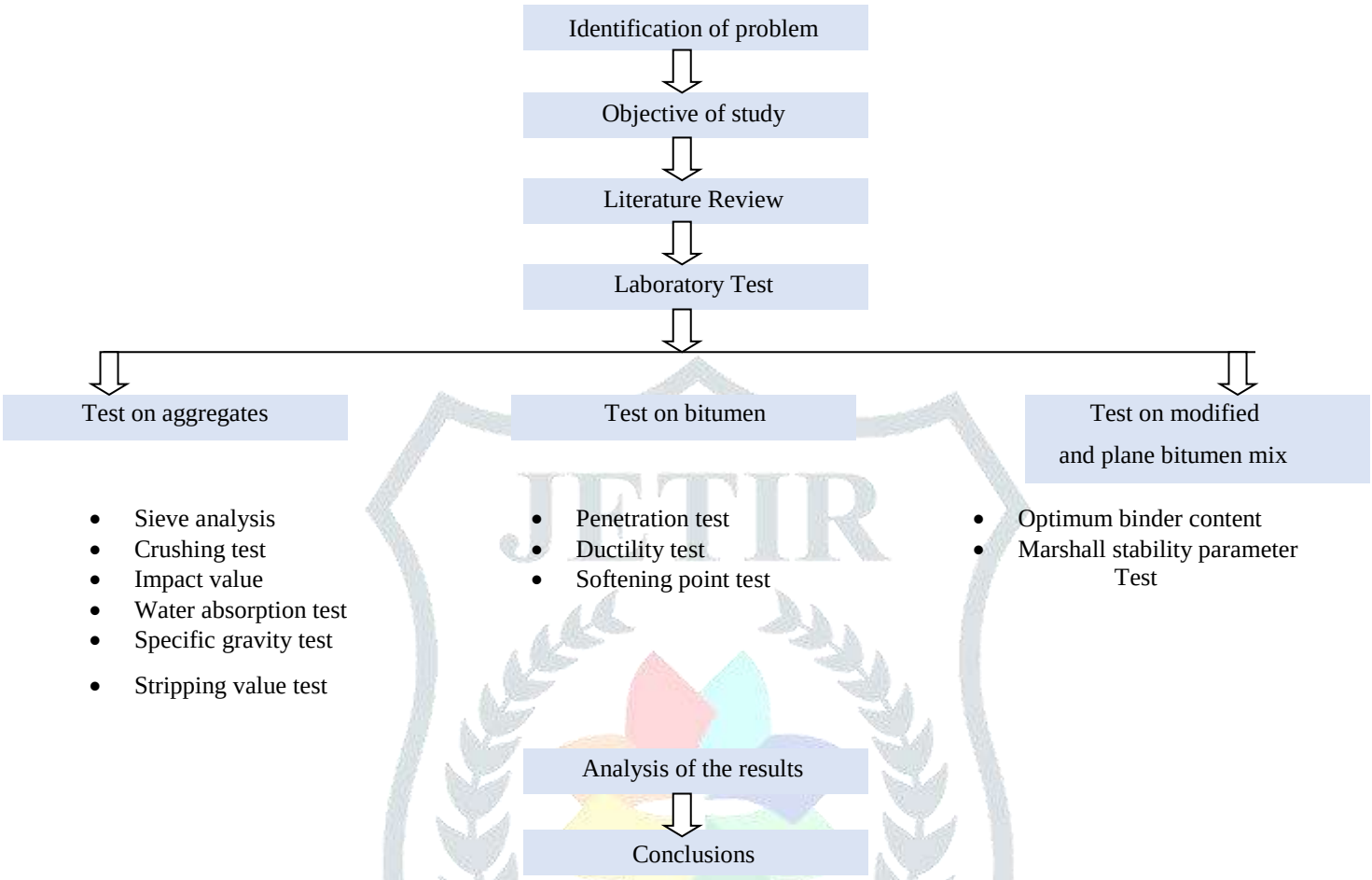
Waste rubber: - waste rubber is obtained from used tyres. It is black to dark in colour and fineness less than 75 micron.
Filler materials: - These are may be lime stone powder, cement ,fly ash, Rock dust or any other hard material of size less than 75 micron.

II Objectives of Study:-Following are the objectives of this present study

- To tests the plain aggregates and polymer coated aggregates and compare their results.
- To find out the Marshall stability and other Marshall parameters of conventional bituminous mix with the varying % binder content and finding the optimal value of binder.

- To study the effect of waste rubber mixed in bitumen with varying the percentage.
- To study the Marshall parameters of the rubber modified bitumen mix with plain aggregates, plane bitumen with coated aggregate mix and also for rubber modified bitumen and plastic coated aggregates.
- To draw the various graphs of Marshall test and comment the conclusion.

III Methodology:- The flowchart depicting the methodology are given as follows.



IV Material Testing:-

1. Gradation of aggregates-

Table1:-Aggregate Gradation for BC Mix Grade I

Sieve size, (mm)	% Passing by weight of total aggregate					Obtained gradation	Desired gradation
	20 mm	10 mm	6 mm	Dust	Cement		
26.5	100	100	100	100	100	100	100
19	76.25	100	100	100	100	92.40	90-100
13.2	21.60	100	100	100	100	74.91	59-79
9.5	0	62	100	100	100	60.40	52-72
4.75	0	9.40	76.90	100	100	46.42	35-55
2.36	0	2.60	21.30	88.30	100	33.44	28-44
1.18	0	1.30	6.10	67.30	100	25.02	20-34
0.6	0	0	1.26	48.50	98	18.67	15-27
0.3	0	0	0	28.80	96.40	12.88	10-20
0.15	0	0	0	11.80	92.90	7.95	5-13

0.075	0	0	0	6.60	76.40	5.67	2-8

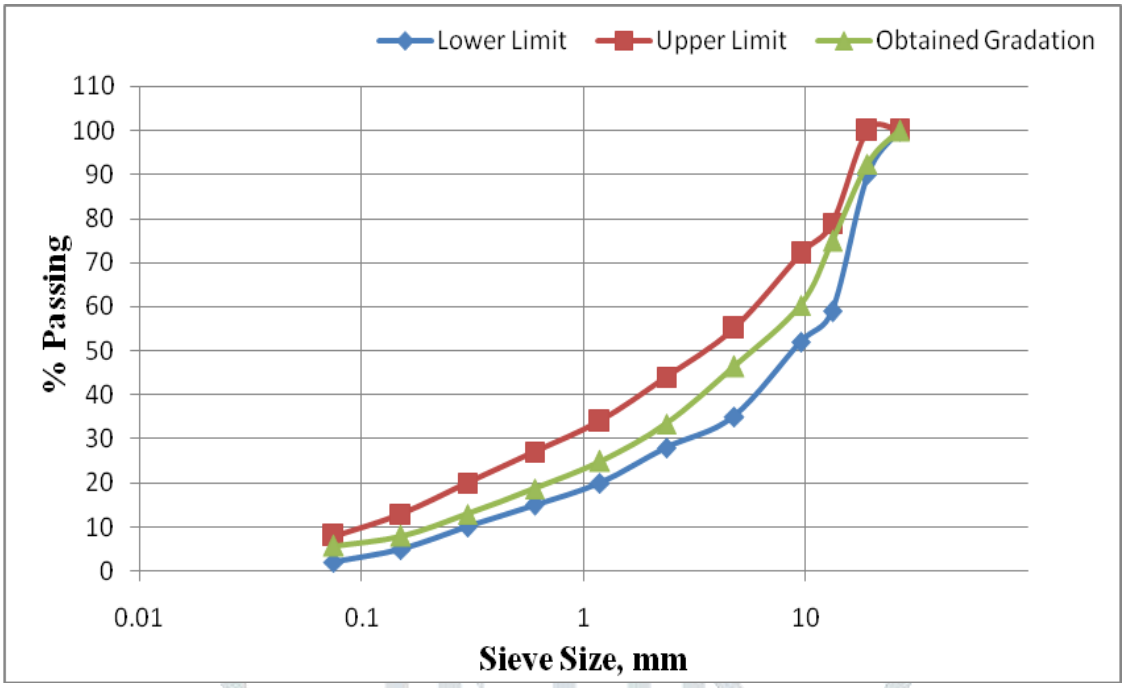


Figure1- Aggregate Gradations for BC Mix Grade I

2. Test on aggregates

The Modification of the Aggregate with LDP Coating

Various tests which are used to find out the properties of aggregates such as Impact test, Specific gravity test, Crushing value test and water absorption test are performed. The results obtained from the test are shown in the tabular as well as in graphical form.

2.1 Impact test

The Table 2 show the Impact strength of the aggregates with varying the amount of LDP from 0.0% to 0.60%

Table2:- Results of Impact Test with Varying the Percentage of LDP

Coating of LDP over aggregates by weight	Impact value in percentage
o.o%	12.92
0.50%	11.45
0.55%	10.78
0.60%	11.13

2.2 Crushing value

The Table 3 show the crushing value of the aggregates with varying the percentage of the amount of LDP from 0% to 0.60%

Table3:- Results of Crushing Test with Varying the Percentage of LDP

Coating of LDP over aggregates by weight	Crushing value in percentage
o.o%	15.41
0.50%	14.67
0.55%	13.48
0.60%	13.93

2.3 Specific gravity and Water absorption test

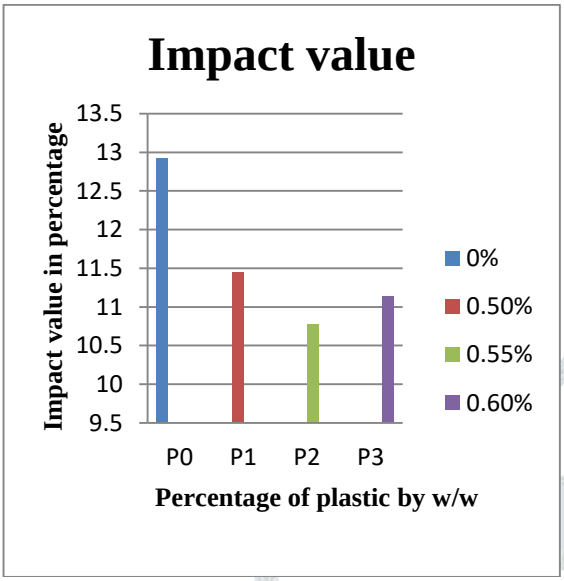
The Table 4 show the specific gravity of the aggregates with varying the percentage of the amount of LDP from 0% to 0.60%, similarly Table show the water absorption test results.

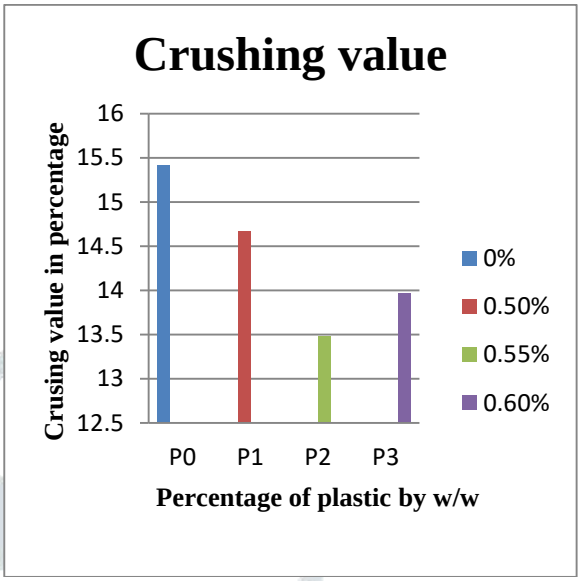
Table4:- Results of Specific Gravity Test with Varying the Percentage of LDP

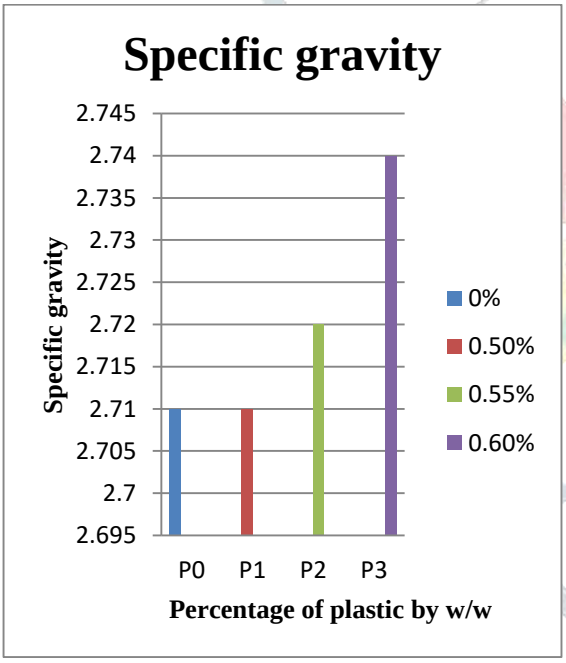
Coating of LDP over aggregates by weight	Specific gravity
o.o%	2.71
0.50%	2.71
0.55%	2.72
0.60%	2.74

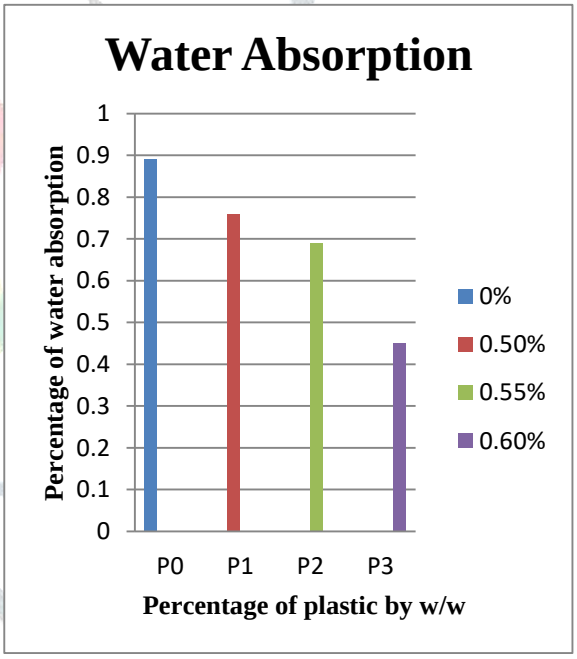
Table5:- Results of Water absorption test with variying the percentage of LDP

Coating of LDP over aggregates by weight	Water absorption in percentage
o.o%	0.891
0.50%	0.76
0.55%	0.69
0.60%	0.45









3. Test on Bitumen

The Modification of Binder with Varying the Percentage of Rubber

The various test which are used to find out the quality of bitumen such as Penetration value test, Ductility value test, Softening point test are performed and results are discuss below.

3.1 Ductility value of bitumen

The Table 6 show the Ductility value of the Binder with varying the percentage of the Rubber from 4% to 10% by weight of binder.

Table6:- Results of Ductility Test with Varying the Percentage of Rubber

Percentage of rubber waste by w/w	Ductility value in cm
0%	77.80
4%	74.51
6%	70.29
8%	67.23
10%	64.53

3.2 Softening point test

The Table 7 show the Softening value of the binder with varying the percentage of the Rubber from 4% to 10% by weight of binder

Table 7:-Results of Softening Point Test with Varying the Percentage of Rubber

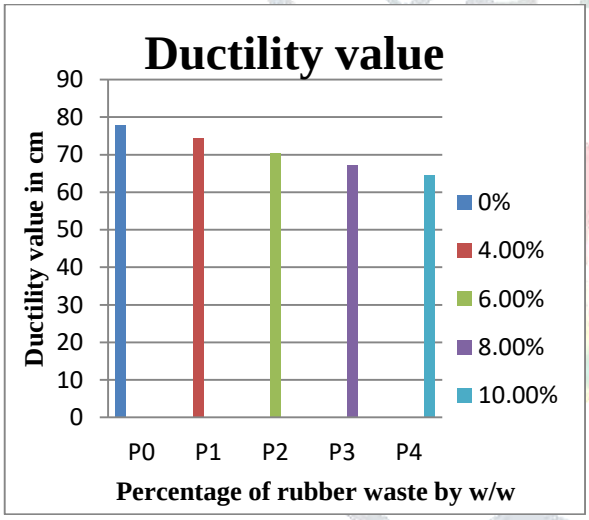
Percentage of rubber waste by w/w	Softening point in degree centigrade
0%	48
4%	51
6%	55
8%	64
10%	69

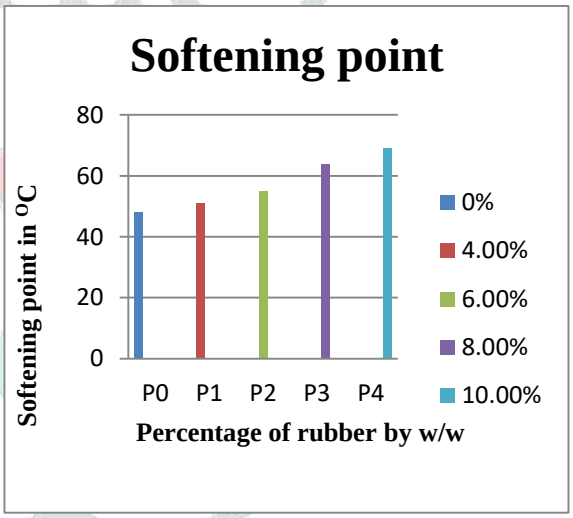
3.3 Penetration test of bitumen

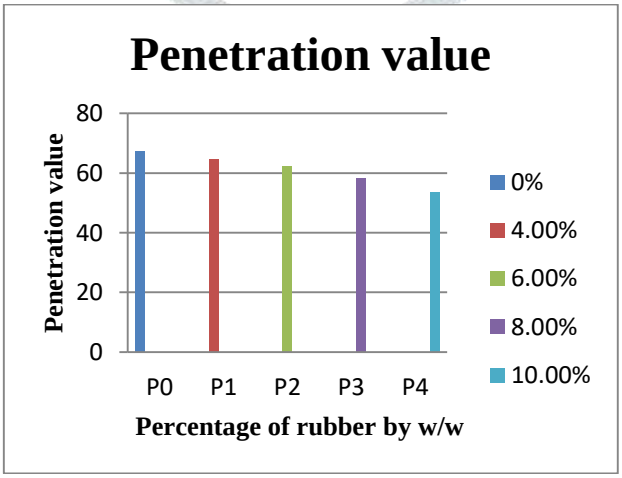
The Table 8 show the Penetration value of the Binder with varying the percentage of the Rubber from 4% to 10% by weight of binder.

Table8:-Results of Penetration Test with Varying the Percentage of Rubber

Percentage of rubber waste by w/w	Penetration value
0%	67.33
4%	64.57
6%	62.17
8%	58.29
10%	53.57







4. The Marshall Parameters of Plain Bituminous Mix with Varying the Percentage of Binder

The Figures and Table 9 shows the test performed on plain bitumen and virgin aggregates with varying the percentage of binder to find out OBC. The various graphs which are given in figure are draw between percentages of binder content to the various parameters.

Table9:- Results of Marshall Test on Plane Bitumen and Aggregate Mix

Properties	Bitumen binder in(%)				
	4.5	**5**	**5.5**	**6**	**6.5**
G_m(g/cc)	2.299	2.313	2.322	2.318	2.298
Vv (%)	6.531	5.310	4.244	3.725	3.608
V_b (%)	10.228	11.374	12.503	13.553	14.532
VMA (%)	16.759	16.685	16.746	17.278	18.140
VFB (%)	61.029	68.169	74.661	78.440	80.110
Stability(KN)	8.12	9.14	9.89	9.28	9.43
Flow(mm)	2.34	2.54	3.22	3.76	4.07

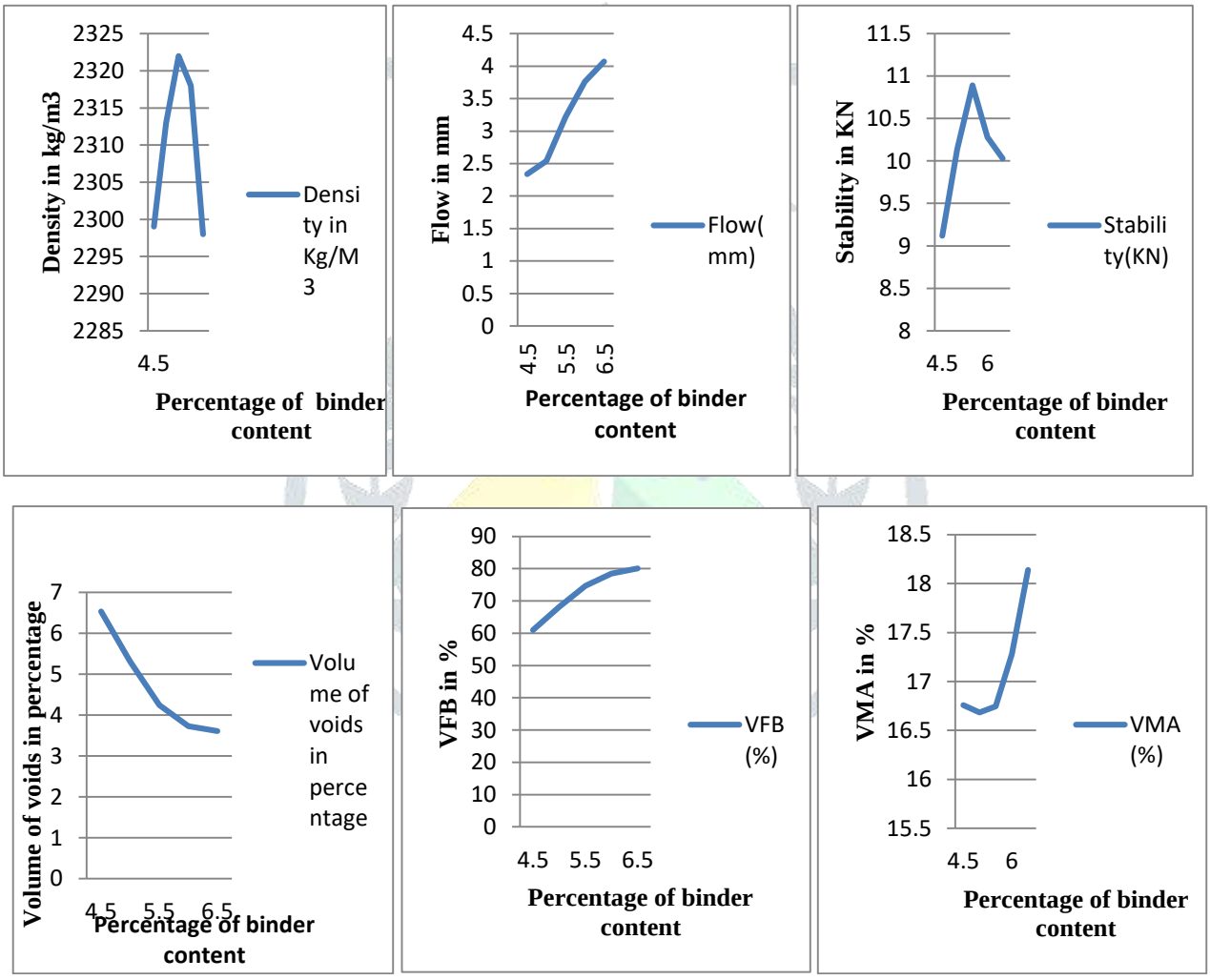


Figure:- Results of Marshall test on Plane Bitumen and Aggregate Mix

5.The Marshall parameters of Plain Bitumen and Coated aggregate mix with Varying the percentage of LDP

Table and Figure shows the test performed on plain bitumen and coated aggregates with varying the percentage of plastic to find out the optimum percentage of plastic. Various Graphs are drown in between percentage of plastic and various Marshall parameters.

Table10:-Results of Marshall Test on Plane Bitumen and Coated Aggregate Mix

Properties	Plastic in (%) over the aggregates by weight			
	0	**0.5%**	**0.55%**	**0.60%**
G_m(g/cc)	2.322	2.328	2.331	2.321
Vv (%)	4.244	3.939	3.718	3.807
V_b (%)	12.534	11.909	11.623	11.481
VMA (%)	16.746	15.848	15.314	15.288
VFB (%)	74.661	75.145	75.897	75.09
Stability(KN)	9.89	10.98	11.39	11.74
Flow(mm)	3.22	3.51	3.65	3.87

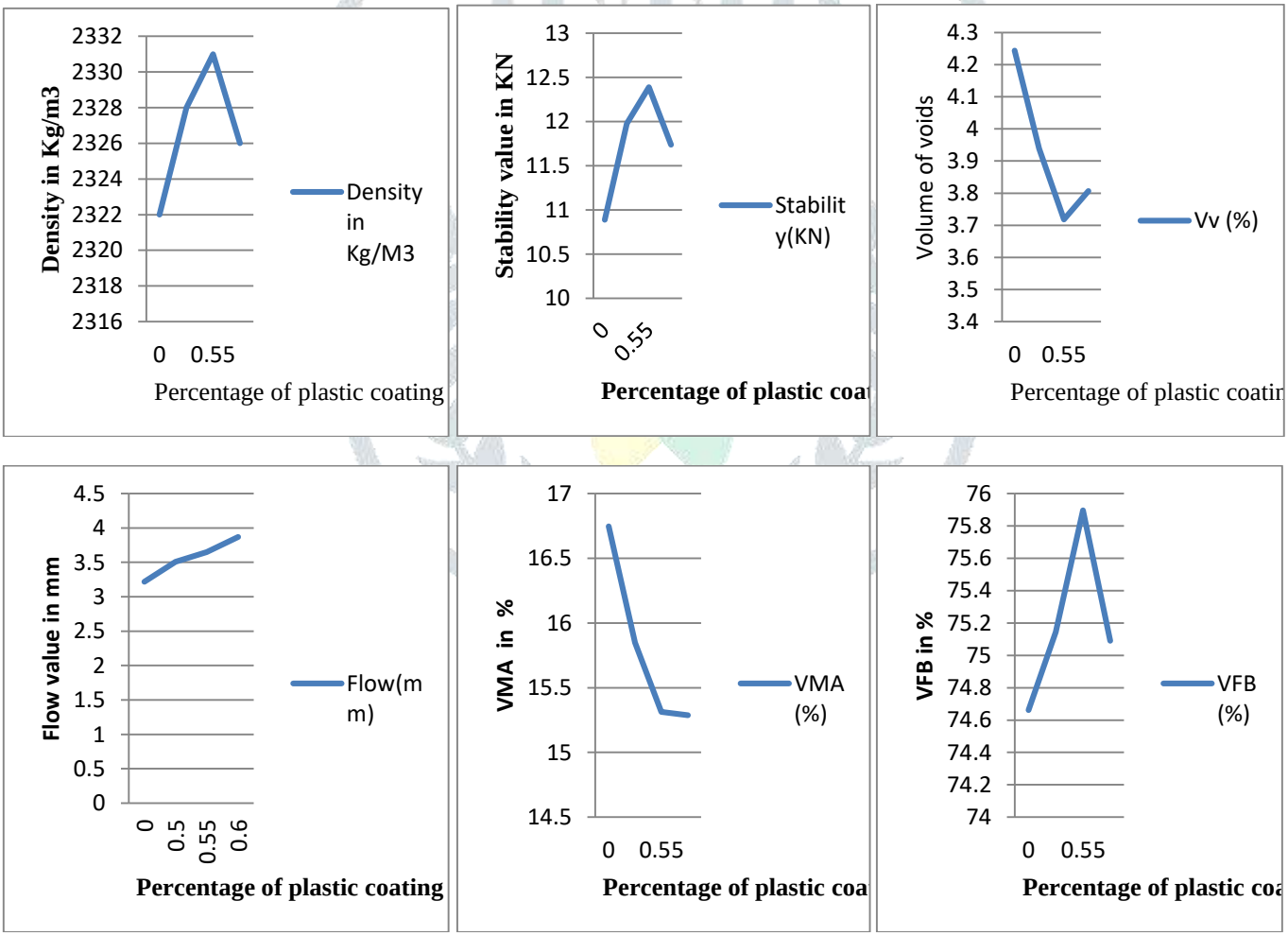


Figure:- Results of Marshall Test on Plane Bitumen and Coated Aggregate Mix

6 The Marshall Parameters of Rubberized Bitumen and Plain Aggregate Mix with Varying the Percentage of Rubber in Binder

Table and Figure shows the test performed on Rubberized bitumen and plain aggregates with varying the percentage of rubber to find the optimum value of rubber .The Figure shows the various graphs draw between the percentage of rubber in bitumen and various Marshall parameters.

Table 11 Results of Marshall Test on Rubberized Bitumen and Plain aggregate Mix

Properties	Rubber in percentage				
	0	4	6	8	10
G_m(g/cc)	2.322	2.325	2.370	2.489	2.487
Vv (%)	4.244	3.876	3.651	3.371	3.421
V_b (%)	12.503	11.126	10.889	10.781	10.401
VMA (%)	16.746	15.002	14.54	14.152	13.822
VFB (%)	74.661	74.163	76.889	76.182	75.249
Stability(KN)	10.89	12.14	12.97	13.69	13.37
Flow(mm)	3.22	3.19	2.86	2.63	2.67

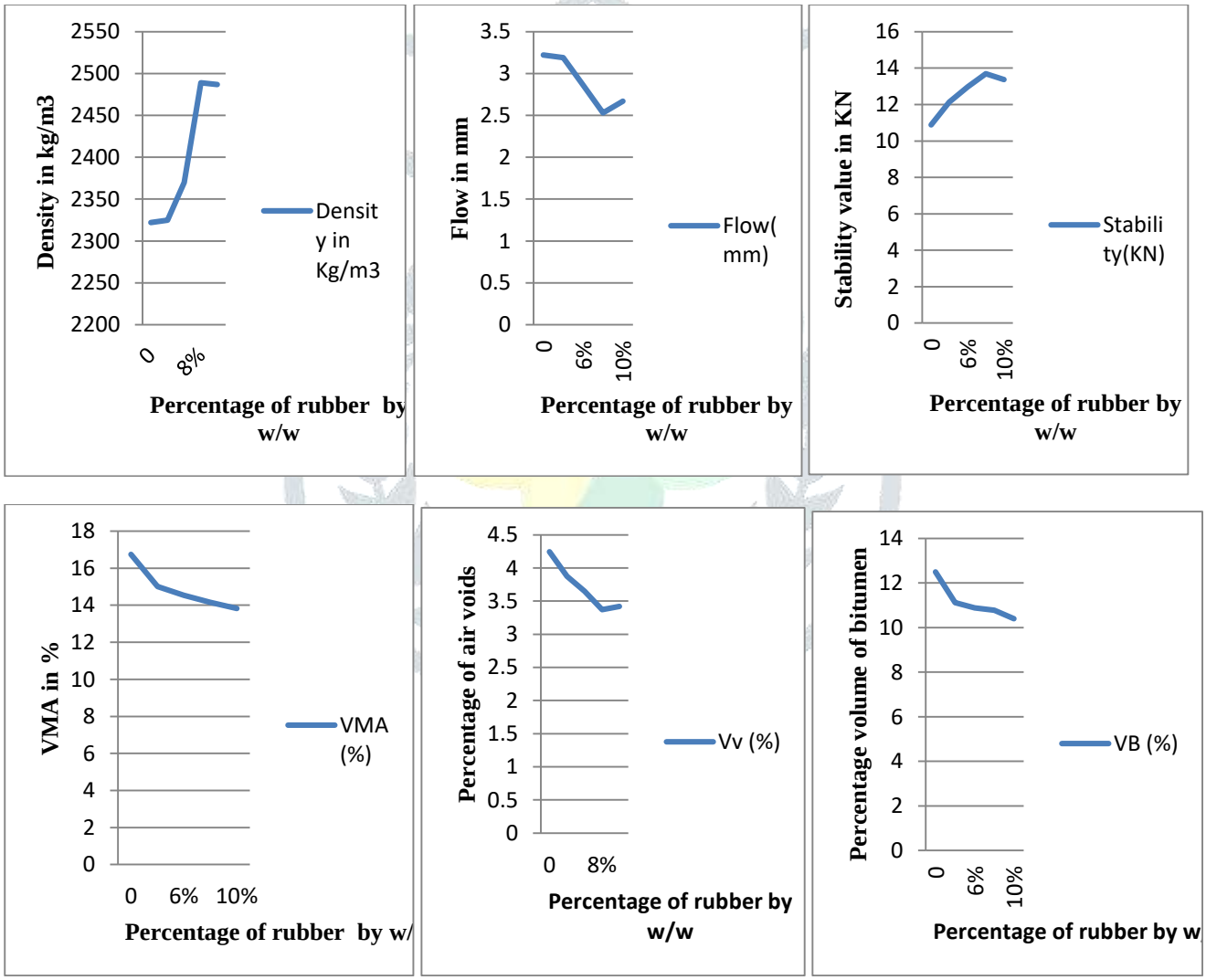


Figure Results of Marshall Test on Rubberized Bitumen and Plain Aggregate Mix

Conclusion:- The Volumetric and Marshall properties of bituminous mixtures for grading-I are satisfying MoRTH -2013 specifications.

a) On comparing the various results of Toughness index, Crushing value, Specific gravity and Water absorption the results are improved when the coating of 0.55% LDP by weight is used. At 0.55% of LDP the toughness value reduced from 12.92% to 10.78% it mean the reduction is about 16.56%, Similarly the crushing value reduced from 15.41% to 13.48% it mean the value dropped by 12.52%.

b) Except that the water tightness is always improved as the amount of coating material increase and as the amount of plastic increases the aggregates become totally impermeable.

c) On comparing the results of various tests of bitumen it is seen that the bitumen become harder that's why the ductility value and the penetration values are reduced, Except the softening point of the bitumen is increased that make it more susceptible to temperature.
d) The ductility reduced from 77.80cm to 67.23cm at the 8% of rubber content and the penetration value reduced by 9.04 at 8% of rubber content. While the softening point of bitumen increases from 48 degree to 69 degree.
e) When a Bituminous concrete mix prepared with plain Bitumen and virgin aggregates the optimum value of stability found at 5.5% of binder content. At this time the stability is maximum which is 9.28 KN.
f) When mix prepared with Plain Bitumen and coated aggregates the optimum value of plastic found at 0.55% of weight of aggregates .This time the stability value increased by 22.73% compare to plain mix.
g) When the mix prepared by Rubberized Bitumen and plain aggregate the stability value become13.69 at 8% of rubber by weight of binder. That is around 1.32 time higher then plain mix.
h) Overall we can say that the addition of rubber and plastic in bitumen mix improve the performance of the bitumen.

Future scope:- The further study we can do it with bituminous mix in BC layer of gradation II and also other pavement layers like DBM, SDBC, BM, etc.

a) In the present study plastic waste is coated to aggregates, mixed in dry mixing process and after adding binder content moulds were prepared for BC mix gradation I. Plastic waste can also be applied directly to bitumen to obtain modified mix by wet mixing process and comparisons made.
b) In this study Marshall Properties for BC layer gradation I have been evaluated with conventional bituminous mix and also with modified bituminous mix. Apart from this, Many properties of DBM, BM, BC and SDBC mixes such as, drain Down characteristics, static tensile strength, static creep characteristics, resistance to rutting and fatigue properties need to be investigated by using VG-30 Bitumen and Plastic waste and Tyre Rubber.
c) There is a need to apply dry method and wet method simultaneously by adding Tyre Rubber in a proportion to aggregates in dry mixing and on the other hand apply plastic waste to bitumen and then prepare a bituminous mix, investigate the results and compare with previous studies.
d) In present study the rubber is added in Bitumen but we can also be replacing aggregates by the rubber of size more than 4.75mm.
e) There is a significant demand to utilize the rubber wastes and thus it is a need to adopt a new technology for proper waste management.

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