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Experimental Study on Modified Bituminous Mix Using Waste High Density Polythene and Crump Rubber

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Abstract: This paper represents an effort taken to produce modified bituminous mix and coated aggregates. Aggregates were coated with 6%, 8%, 10% of high density polythene and 8%, 10%, 12% of crump rubber were mixed in bitumen. Different moulds were prepared with different combinations and compared with conventional bitumen mixes by conducting marshall stability test to check its strength, flow value, stability value. Optimum percentage of crumb rubber was found to be 8%. Then crumb rubber percentage is kept constant and HDPE percentage is varied as 6%, 8%, 10%. Highest stability is achieved for all mix with 8% CRMB combination with 10% of HDPE giving more satisfied results comparing to conventional bitumen.

Keywords: Bitumen, CRMB, Crumb rubber, HDPE

1. INTRODUCTION

The disposal of waste tyres has become problem in worldwide due to increase in the number of automobiles, the demand of tyre and its replacement has increased in recent years. The discarded use tyres has increase significantly which has proven to be burden on the environment, landfill, health and safety risk. The traffic volume is on the high rise and increases the demand of road with high wearing capacity and service life span.

Road constructed on agriculture zone and water prone areas are easily affected by pot holes due to the seepage of water. Effective measures should be taken to reduce the best tyre or make alternative use in many ways such as road construction. One of the way to reduce the waste tyre is to incorporate in to the bitumen and asphalt as crump rubber modified. In this study, the attempt is to utilize the waste material such crump rubber and high density polyethylene. By this we only can not only use the environmental hazardous material but also increase the strength and durability of roads. Modified bituminous mix and coated aggregates with 6%, 8%, 10% of high density polythene and 8%, 10%, 12% crump rubber were mixed and different moulds are prepared of different combinations.

2. OBJECTIVES OF PROJECT

I. To investigate properties of Rubber/ Aggregate.
II. Experimental assessment of strength of flexible pavement& modified bitumen pavement.
III. Comparison between test results of conventional & modified bitumen pavement.
IV. To identify the best mechanism of adding the polyethylene (dry or wet process) in aggregate
V. Environment - There is huge problem of disposal waste tyre by using this waste tyre we protect the environment.
VI. Strength -By replacing rubber in bitumen it increasing its strength which gives better strength as compare to normal road.
VII. By giving coating to aggregate which increases strength of aggregate.
VIII. Economy – As compare to waste rubber bitumen is costlier by replacing this waste tyre in bitumen we can reduces the cost, hence economy can be achieved.

3. EXPERIMENTAL MATERIALS USED

A. Bitumen

The grade of bitumen used for this research work VG30. It was soured from hot mix plant from Yerawada in Pune.

B. Crump Rubber

For this research work crump rubber of 1 to 2 mm size is obtained by shredding waste tyres of automobile from Prabhat Tyres, Kothrud.

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C. Coarse Aggregate

The coarse aggregate used for this research work was 6mm, 10mm, 12mm size. It was sourced from stone crusher from Hot Mix Plant Yerawada in Pune.

D. Fine Aggregate

The fine aggregates used for this research work was sourced from Hot Mix Plant Yerawada in Pune.

E. High Density Polythene

Casting and curing of specimens were done with the potable water that is available in the Hot Mix Plant Yerawada in Pune. The water used is free from any visible impurities.

4. DENSE BITUMINOUS MACADAM MIX PROPORTION

The DBM mix was designed for Marshall Stability test using VG30 grade bitumen, 20mm aggregate, 10mm aggregate, 6mm aggregate, crushed sand and filler.

Table 1. DBM Proportion

Bitumen VG-30 grade	4.3% by weight
	4.5% by weight
	4.7% by weight
20 mm aggregate	42% by weight
10 mm aggregate	0.8% by weight
06 mm aggregate	0.8% by weight
Crush Sand	40% by weight
Filler (Stone Dust)	2.0% by weight

5. METHODOLOGY

1. Selection of Materials.
2. Basic Tests performed on bitumen and aggregate.
3. Prepare DBM mix design for VG30 grade of bitumen.
4. Prepare conventional bitumen sample .
5. Testing of conventional concrete specimen.
6. Result of conventional bitumen.
7. Preparation of modified bitumen using 8%,10%,12% CRMB & 6%,8%,&10% of HDPE
8. These modified bituminous mix moulds are tested by conducting Marshall stability
9. Result for modified bituminous mix.
10. Comparison between Conventional bitumen and modified bituminous mix.

6. EXPERIMENTAL INVESIGATION

A. Penetration Test:

Penetration Test apparatus was used to determine penetration value of bitumen. Penetration value is distance penetrated by standard needle in bitumen in specified time under specified load and temperature. Penetration value is measured in tenth of millimetre.

B. Softening Point Test:

This test is done to determine the softening point of asphaltic bitumen and fluxed native asphalt, road tar, coal tar pitch and blown type bitumen as per IS: 1205 – 1978. The principle behind this test is that softening point is the temperature at which the substance attains a particular degree of softening under specified condition of the test.

C. Marshall Stability Test:

The Marshall Stability and flow test gives the performance prediction measure for the Marshall Mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute.

Figure 1. Mixing of Coated Aggregate and CRMB

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Compaction of samples

After preparing batch of the DBM mix sample, it requires to be compacted before testing. Compaction is done with Automatic Marshal Compactor machine present at the lab at Pune Municipal Corporation, Hot Mix Plant, Yerawada. Sample placed in the mould were compacted in the compaction machine for 75 blows each side. Filter papers were added to the both sides of the mould. The moulds were kept for 24 hours before testing.

Figure 2. Compaction of test sample

After compaction of sample, After 24 hour's moulds are kept in temperature controlled water bath at 60^0C for 30 minutes.

These moulds are loaded in Marshall Stability test apparatus.

Marshall Stability of a test specimen is the maximum load required to produce failure when the specimen is preheated to a prescribed temperature placed in a special test head and the load is applied at a constant strain (5 cm per minute). While the stability test is in progress dial gauge is used to measure the vertical deformation of the specimen. The deformation at the failure point expressed in units of 0.25 mm is called the Marshall Flow value of the specimen.

Figure 3. Marshall Stability test setup

5. RESULTS

Table 2. Test Results on Conventional Bitumen

Sr.No	Test	Results	References
1	Softening Point (^{o}C)	49.40	IS:1205-1978
2	Penetration at 25^{o}C 100 gm	53	IS:1205-1978
3	Specific Gravity	1.01	IS:1205-1978
4	Flash Point (^{o}C)	262	IS:1205-1978
5	Ductility (Cm)	100	IS:1205-1978

Tests are performed with reference of IS: 1205-1978 and all test results are within specified limit for Grade VG 30 as per IS:73:2006. So bitumen is suitable for Experimental work.

Table 3. Test Results of CRMB

Sr. No	Test	Plain bitumen	8% CRMB	10% CRMB	12% CRMB
1	Softening point	49.4	57.3	59.7	60.3
2	Penetration at 25^{o}C	53	42.33	41.76	36.33

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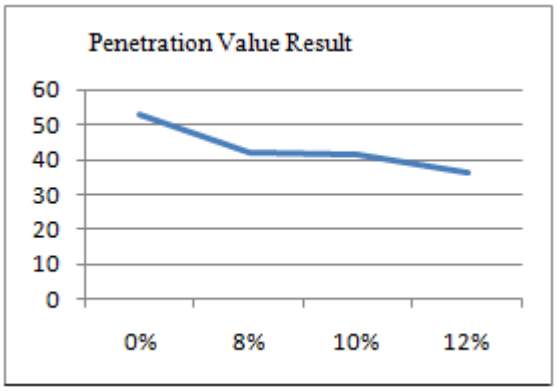
Graph 1 PenetrationValueResult



Graph 2- Softening Point Result

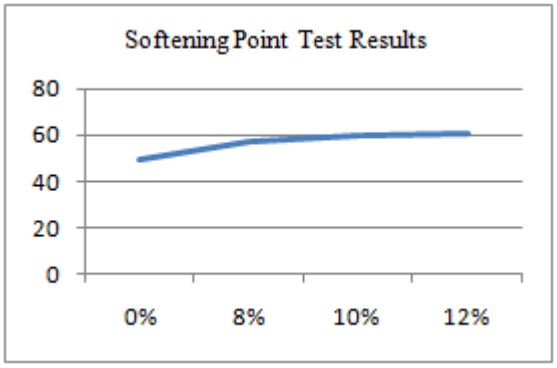


Table 4. Marshall Stability Test Results on conventional mixes

Bitumen content	Division	Stability (Kg)	Average Value	Flow (mm)
4.3	270	1179		4.5
	245	1070	1055.6	4
	210	917.49		3.5
4.50	285	1245		4
	220	961.18	1077.63	4.5
	235	1026.72		4
4.70	195	851.96		4.5
	230	1004.57	830.02	5
	145	633.504		5

Graph 3 Marshall Stability Test Result on Conventional Mixes

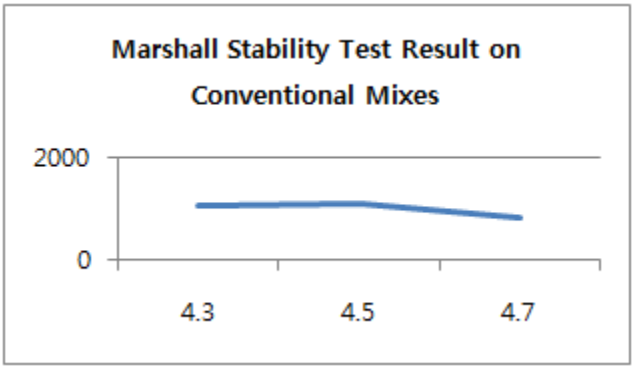


Table 5. Marshall Stability Test Results on CRMB Mixes

Crump Rubber %	Division	Stability (Kg)	Average	Flow (mm)
8%	275	1201.47		3.5
	240	1048.56	1043.22	4
	270	1179.63		4
10%	280	1223.3		3.5
	265	1157.7	1194.13	4.5
	275	1201.4		4
12%	265	1157.7		4.5
	250	1092.2	1048	4
	230	1004.8		7

Graph 4 Marshall Stability Test Results on CRMB Mixes

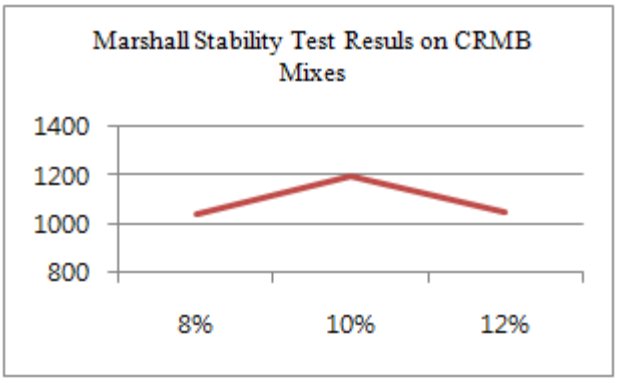


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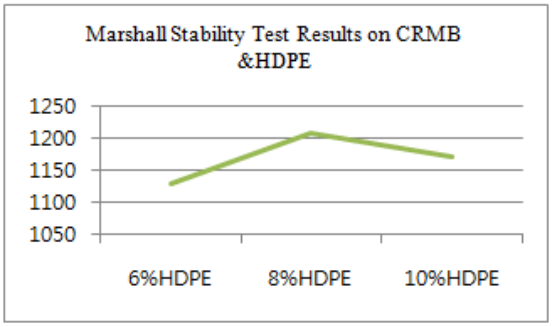
Table 6. Test results on CRMB & High Density Polyethylene

CRMB+HDPE	Division	Stability (kg)	Average (kg)	Flow (mm)
10%CRMB+ 6%HDPE Coated Aggregate	260	1135.94	1128.66	3
	245	1070.40		3.5
	270	1179.63		4
10%CRMB+ 8%HDPE Coated Aggregate	280	1223.32	1209.76	4.5
	265	1157.785		4
	285	1248.16		3.5
10%CRMB+ 10%HDPE Coated Aggregate	270	1179.63	1172.35	4
	260	1135.94		3.5
	275	1201.47		4

Graph 5 Marshall Stability Test Result on CRMB and HDPE coated aggregate



Summary of Results

- Marshal stability result on conventional bituminous mix-

1) Maximum stability (kg) = 1077.63kg, at binder content = 4.5%

2) Minimum flow value (mm) = 4mm, at binder content = 4.3%

- Marshal stability results on Crumb Rubber + HDPE Coated Aggregate

(Optimum binder content is 4.5%)

1) Maximum stability (kg) = 1209.76kg, at 8% HDPE and 10% CRMB.

2) Minimum flow value (mm) = 3mm, at 6%HDPE and 10% CRMB

- Marshal stability results on CRMB mix –

1) Maximum stability (kg) = 1194.13kg, at binder content 4.5% and crumb rubber 10% of binder

2) Minimum flow value (mm) = 3mm, at 4.5% binder content and crumb rubber 10% of binder

6. CONCLUSION

Penetration values and softening points of plain bitumen can be improved by modifying it with addition of crump rubber. Optimum binder content for conventional bitumen was found to be 4.5% .Optimum value of crumb rubber in CRMB was found to be 10%. Dry Process (polymer coating of aggregates) is more useful as compared to Wet Process (adding polymer in the binder) for manufacturing modified mixtures, as it can accommodate higher amount of waste plastic as modifier and results more stable mixtures. In addition with 10% crumb rubber optimum content of HDPE was found to be 8%. Using waste rubber and plastic reduces threat to environment and also improve the road quality.

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