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Use of Waste Plastic in Flexible Pavement

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***Abstract* - The use of waste plastic in road construction plays an important role in the development of a good and stable pavement and this makes cost effective. As we know that India is a developing country so by using waste plastic in pavement work economy of the country can be improved. In India for developing of the road network to connect various places by bituminous road should be constructed because initial cost of construction is less. This study is carried out the use of waste plastic in road construction by replacing some amount of bitumen. And the amount of waste plastic is 4%, 6%, 8%, 10% in place of bitumen. By analysing the all test on Marshall Mix design, we finally conclude that 8 percentage of waste plastic will give us the optimum value. So by using plastic cost can also be minimised. And in our project we have analysed the different properties of bitumen and its mixture with aggregate by different tests and have checked the impact of adding plastic.**

Keywords-

I. INTRODUCTION

Waste Management is one of the dominant conceptions recent years. Nowadays, the recycling of various wastes (plastic waste) produced from multiple Industries is a significant problem. In last decades, utilization of industrial waste used in road work or paving with great interest in many developing and industrialized countries. Use of waste plastic in pavement design can prove as the partial solution towards minimizing pollution caused by plastic.

If the Road surface is paved with neat bitumen then there are chances of developing cracks in cold weather and bleeding in hot climate, possess low load bearing capacity and can cause severe damages because of heavy axle load due to rapid growth in infrastructure.

So by using plastic waste in the bitumen the strength, durability, stability, load bearing capacity can be increased. This study shows the use of plastic waste in hot bituminous mix to increase the pavement performance, provide low-cost road sand make the environment eco-friendly.

A. Objective

- To study the fundamental properties of plain bitumen and aggregates
- To study the effect of plastic waste on the BC mix.
- To study the stability and strength of the pavement.
- The main motive for these experimental studies to conduct the comparative studies of partial replacement of bitumen with 0%, 4%, 6%, 8%, 10% as an aggregate in flexible pavement.
- To study the strength characteristics of plastic waste.

B. Scope

- The scope of the investigation is to evaluate the performance of flexible pavement by using waste plastic in the bitumen mix.
- Develop a technology, which is environmental friendly.

II. LITERATURE REVIEW

Teerthananda Sagar CS et. al. 2018 [1] studied on Utilization of Waste Materials in Flexible Pavement Construction. And the main objective of this experiment is to provide better finish, stability, binding property, resistance to water and durability to the pavement. Bereket Keflemariam et al. 2017 [2] worked

on Reuse of waste plastic for flexible pavement construction. The main objective of this experimental investigation is to provide tools to evaluate and to improve the properties of pavement using waste plastic such that it may be more confidently employed in road work. V.Rushendrareddy et al. 2017 [3] used waste plastic in flexible pavements. Use of plastic in the road construction with the bitumen not only increases its life but also economically sound and environmentally friendly. Plastic wastes are used as a modifier of bitumen to improve some of the bitumen properties. Roads that are constructed using plastic called plastic roads. Performs better when compared to the typical bituminous road. It founds those roads which are not striping at the time of contact of water. Using of higher percentage if plastic decreases the usage of bitumen by 10%. It also increases the strength and performance of the road. Amit Tyagi et. al. 2016 [4] used plastic Waste in Construction of Flexible Pavement. This provides anInnovative Waste Management Idea. The plastic waste used in flexible pavement comprising of carry bags, polymers, cups etc. can be utilized for coating a over aggregate in pavement construction. R.A. Bondre et. al. 2015 [5] worked on the use of Plastic Waste Material in Flexible Pavements. Use of plastic waste with Bitumen in the pavement construction not only increases its life and smoothness but also makes it economically sound and environment friendly. It also increases the strength, stability, flexibility and performance of the road. Plastic increases the melting point of Bitumen and hence mixing can be done is better and easier way. The addition of plastic waste in road construction eliminates the shrinkage cracking of pavement surface.

III. MATERIALS

The following materials are used in constructing the road surface courses are:

1. Aggregates
2. Bitumen

Along with these materials the plastic waste (Polyethylene) is used which considerable reduced the amount of bitumen content.

To make the impervious compacted mix, bitumen is added in adequate quantity and will have acceptable elastic properties.

The aggregates are classified as Coarse Aggregate (particles which are retained on 4.75 mm sieve), Fine Aggregate (particles which are passing through 4.75 mm sieve and retained on 75µ sieve) and Fillers (passing through .075 mm sieve).

IV. MIXING OF PLASTIC

Dry process:-The stone aggregates are heated at 170^0c temp. and mixed with hot bitumen (160^0 C) and then the mix is used for road construction. When the shredded plastic is coated with aggregate, it improves the quality concerning voids, moisture absorption, and soundness. The coating of the plastic waste decreases the porosity and helps to improve the quality of the aggregate and performance in the flexible pavement.

Wet process: -In this process the bitumen is heated at temperature of 170°c and then the polymer wastes (plastic waste such as polyethylene and bottles) are mixed with heated bitumen. After this the mixed bitumen is stirred properly by strong mechanical stirrer and continuous rotation, then the plastic waste is blended with bitumen and after this the blended bitumen mix is cool up to 120°c and mixed with aggregates and laid on the land surface. This is the method in which the limitations of dry process can be overcome, if the heat losses and temperatures are controlled effectively then tis process is effective in the sense of minimizing the production time and productivity can be improved. In our project wet process is used.

V. TEST RESULTS ON AGGREGATES AND BITUMEN

Table I
Test on Aggregates

S.No	TESTS	RESULTS
1.	Aggregate Impact Value	17%
2.	Aggregate Crushing Value	27%
3.	Aggregate Abrasion Value	33%
4.	Flakiness and Elongation Index	18.49%
5.	Specific Gravity	2.60
6.	Water Absorption	0.835%

Table II
Penetration Test Results on Bitumen

S.No.	Plastic Content	Average Penetration (mm)
1.	0	8.17
2.	4	7.40
3.	6	6.83
4.	8	6.46
5.	10	5.97

Table III
Flash and Fire point Test Results on Bitumen

Plastic Content (%)	Flash point	Fire point
0	240	280
4	245	290
6	255	285
8	250	295
10	255	295

Table IV
Softening Point Test Results on Bitumen

S.No.	Plastic Content (%)	Softening point (^{o}C)
1.	0	52
2.	4	61
3.	6	68
4.	8	75
5.	10	85

Table V
Specific Gravity test Results on Bitumen

Plastic Content (%)	Weight of bitumen (gm)	Weight of water replaced by bitumen (gm)	Specific Gravity
0	50	44.5	1.12
4	50	42	1.19
6	50	40.5	1.23
8	50	39	1.28
10	50	38.5	1.30

VI. MARSHALL MIX DESIGN

Grading of aggregate should be done before mix design. For this purpose sieve analysis of aggregates have been done having size 19mm,13.2 mm,4.75 mm, 2.36 mm, 1.18 mm, 300um, 75 microns, and stone dust. Grading requirement of BC for this study should satisfy the MORTH. The aggregate gradation should be in the desired limits and within the desired limit as per MORTH table 500-7 for bitumen content of Grade 2.

Table VI

Material Requirement for One Sample as per Gradation

MATERIAL	WEIGHT(gm)	SPECIFIC GRAVITY
CA	468	2.74
FA	240	2.65
STONE DUST	444	2.60
FILLER	48	2.48
BITUMEN	49.5	1.12

Table VII

Marshall Results for Plane Bitumen

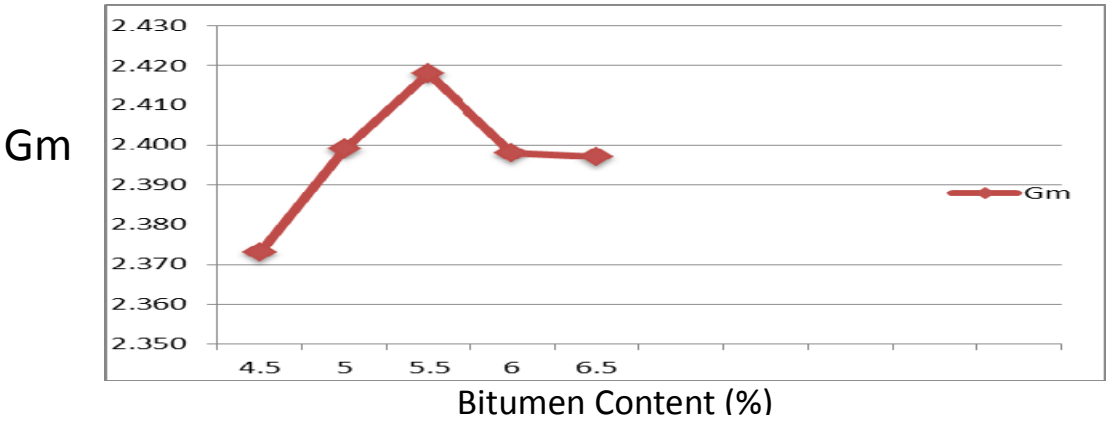
Mould No.	Wt. in the air (Wm)	Wt. in water (Ww)	Gm=Wm/(Wm-Ww)
1	1131.00	679.50	2.505
2	1120.50	670.00	2.490
3	1142.00	683.50	2.518
4	1157.00	699.50	2.529
5	1151.00	700.00	2.552
6	1131.00	685.00	2.534
7	1158.50	701.00	2.532
8	1149.50	692.00	2.513
9	1216.50	735.00	2.526
10	1159.00	698.50	2.517

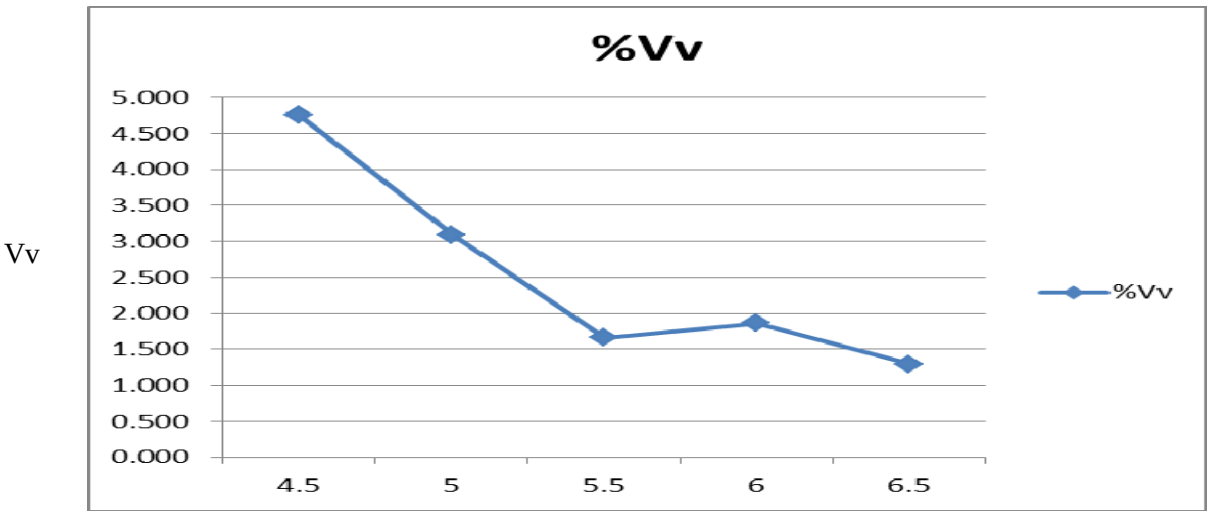
Mould No.	Flow value (mm)	Stability	Stability (Kg)
1	2.40	3.00	828
2	2.25	4.25	1173
3	1.90	4.00	1104
4	3.00	4.95	1366.20
5	2.98	4.60	1269.5
6	2.90	4.30	1186.8
7	3.20	3.50	966
8	2.40	3.50	966
9	3.80	3.60	993.60
10	3.60	2.40	662.40

Table VIII

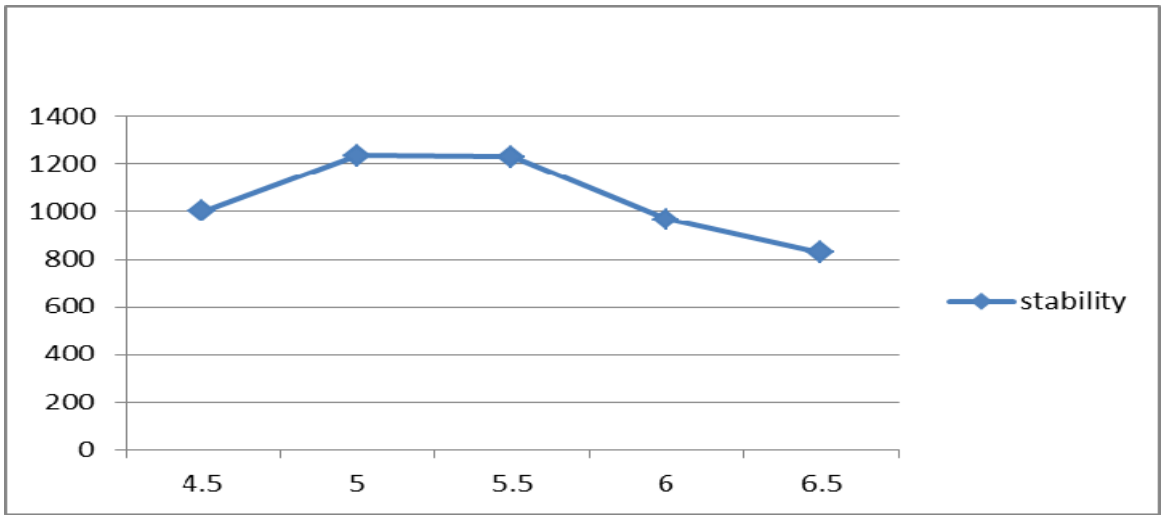
Marshall Results for Waste Plastic Added Bitumen

Plastic Content (%)	Gm	Stability (Kg)	Flow value (mm)
0	2.399	1235.10	4.48
4	2.365	1257.20	2.20
6	2.410	1306.40	2.60
8	2.439	1372.50	1.90
10	2.447	1251.40	1.75



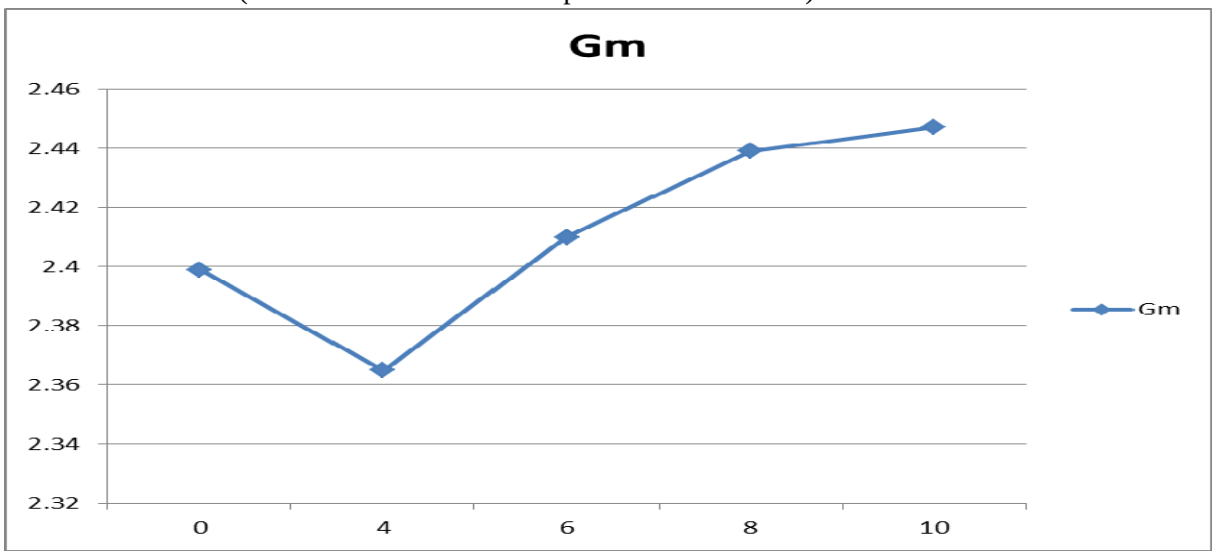


Stability (Kg)

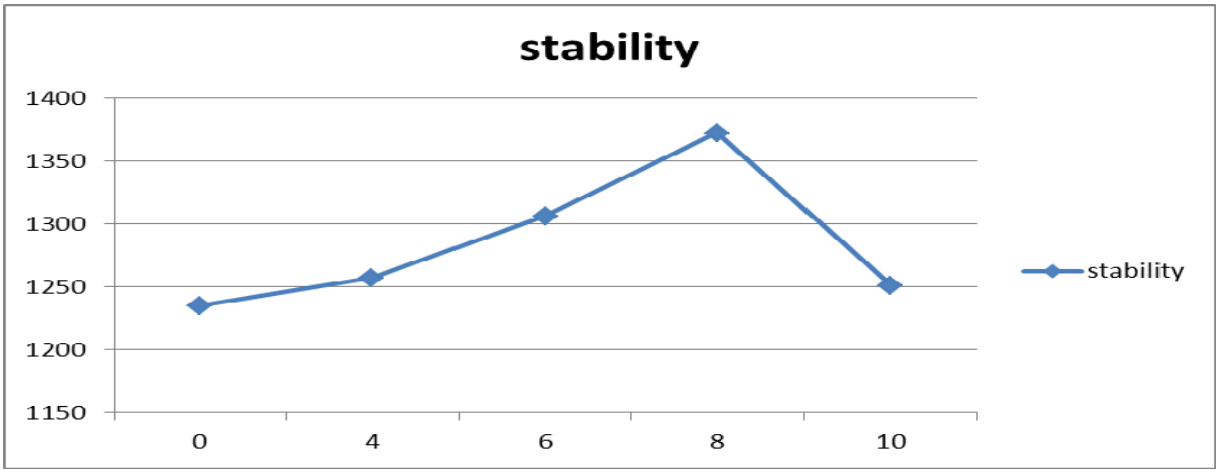


Bitumen Content (%)

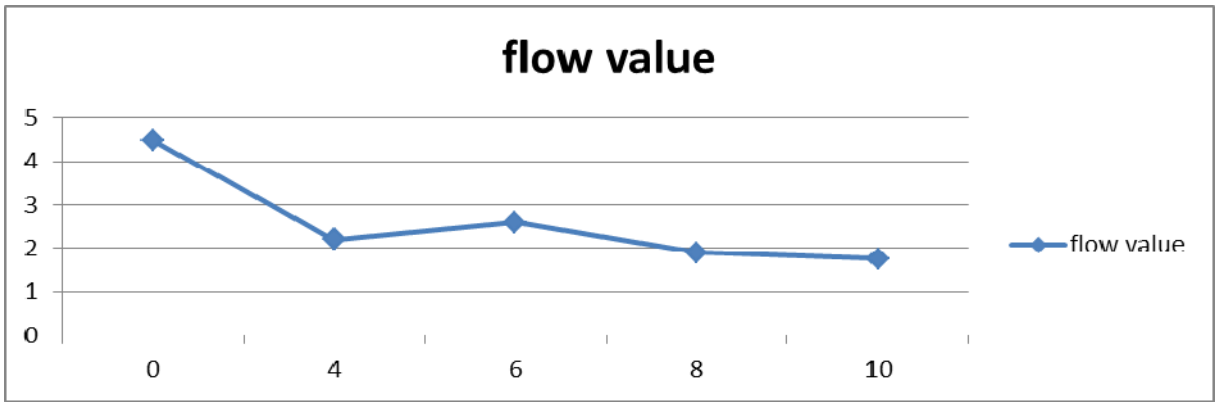
(Marshall Mix Result's Graph of Plane Bitumen)



Plastic content (%)



Plastic content (%)



Plastic content (%)

(Marshall Mix Results Graph for Waste Plastic Added Bitumen)

VII. CONCLUSIONS

- In this experimental study Bituminous Concrete, are prepare with VG30 grade of Bitumen. The effect of the addition of plastic waste like polyethylene in the form of locally available artificial packets of milk, carry bags etc. Bituminous mixes has been studied by varying range of polyethylene from 4% to 10% at an increment of 2%.
- The plastic waste shall be shredded to the size of 2-3 mm width and 8 mm in length.
- The plastic waste shall mainly consist of polyethylene and should be free from PVC.
- The specific gravity of the RAP material is slightly more than the fresh aggregate sample.
- Material shall not be black.
- With the help of this experimental study it was observed that the use of waste polyethylene in the bitumen which was in the form of milk packets, carry bags improved the engineering properties of bituminous mix and resistance to moisture in the mix is also increased. Hence, this analysis beneficially, not only for the non-degradable plastic waste but also gives the improve road construction material in the top layer (surface courses), so that providing it much more durability.
- This experimental study investigates not only deploying the waste non-degradable plastics but also gives us an improved pavement with better strength, stability and more life duration.

VIII. FUTURE SCOPE

- It acts as an Environmental savior. Due to lack of dumping sites in the present scenario, there is a need to save the land, so by using this process environment can be saved.
- This process can be assumed to be the economic process as fewer transportation costs require, and also the construction cost is less.
- To produce and secure a system of sale based packed precast concrete batches, in which CNC waste and recycled coarse aggregate concrete will be present.
- The Indian Govt. is decided to build 2 crore toilets and it is assured that it will create a demand in waste plastic if the toilets are constructed using “Plastone Blocks”.

IX. REFERENCES

[1] TeerthanandaSagar CS et. al. 2018 “Utilization of Waste Materials in Flexible Pavement Construction” Volume: 05 issue: 12|Dec 2018, e-ISSN: 2395-0056, p-ISSN: 2395-0072.

[2] BereketKeflemariam et al. 2017 “Reuse of waste plastic for flexible pavement construction”

[3] V.Rushendrareddy et al. 2017 “Use of waste plastic in flexible pavements”. Volume 8, Issue 5, May 2017, pp.350-356.

[4] AmitTyagiet. al. 2016 “Use of Plastic Waste in Construction Of Flexible Pavement” Special Issue-2016, ISSN: 2278-0181.

[5] R.A. Bondreet. al. 2015 “Use of Plastic Waste Material in Flexible Pavements” ISSN No. (Print): 0975-8364, ISSN No. (Online): 2249-3255.

[6] H. K. Sharma 2015 “Utilization of Waste Plastic in Construction of Pavement” e-ISSN: 2348-4470, Print-ISSN: 2348-6406.

[7] IS Code IS 2386 (Part-I, IV) “Reference Standards. IS: 2386(Part IV)-1963 Methods of test for aggregate for concrete Part IV Mechanical Properties.

[8] Miss Apurva J Chavan 2013. “Use of Plastic Waste in Flexible Pavements” Volume 2, Issue 4, April 2013 ISSN: 2319 – 4847.

[9] Shirish N. Nemade* And Prashant V. Thorat.2013 “Utilization of polymer waste for modification, Scientific reviews, and chemical communication, 3(4), 2013, ISSN 2277-2669, 198-213.

[10] Brajesh Mishra et.al. 2015 “A Study on Use of Waste Plastic Materials in Flexible Pavements” Vol. 4, Issue 8, August 2015, ISSN No. (Online): 2319-8753, ISSN (Print): 2347-6710.

[11] IS Code: IS: 1203-1978; “Determination of Penetration” Bureau of Indian Standard.

[12] IS Code: IS 1205-1978. “ Softening point is the temperature at which the substance attains a particular degree of softening under specified conditions,

[13] IS Code: IS 1208-1978. Methods of testing tar and bituminous material –. Determination of ductility (first revision).