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Experimental Study of Dry Mix Process in Road Construction by Adding Recycled Polypropylene

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Abstract: ***Plastic waste a major component of solid waste which cannot dispose without treatment Due to increasing in population. In urban areas there is problem of waste plastic Polypropylene plastic was found to be an effective mixes used in flexible pavements. Now a day the life of pavement is decreasing due to heavy traffics because of this thing it cause potholes in pavement. There are two methods of adding plastic in pavement are Wet process and Dry process. In this study aggregate are coated with plastic by 10 % which was optimum plastic content have been found by Marshall Stability method. The coated aggregate improve physical properties of aggregate. Plastic roads can be a used in India's hot and extremely humid climate, where temperatures is more than 50°C and due to heavy rain create havoc, leaving most of the roads with big potholes.***
Keywords: Aggregate, Marshall Stability, Polypropylene, Coated aggregate, Bitumen, Flow value

I. INTRODUCTION

The threat of disposal of plastic waste cannot solve until the practical steps are not initiated at the ground level. There are two methods which is possible to improve the stability of road. In this Studies reported in the used of re-cycled plastic, mainly polypropylene, which reduces rutting and cracking on surface of pavement. From many studies its is prove that by using plastic waste in pavement its improve the stability and also life of pavement Plastic is a very versatile material. Due to the industrial revolution, there is large scale production waste plastic seen to be a cheaper and effective raw material. In today era. Plastic used every where starting from agriculture to packaging Plastic waste is a non-biodegradable material and many researchers found that plastic waste can remain up to long period without any degradation . There are many studies have prove the health problem is caused by improper disposal of plastic waste. The health problems includes problems in human beings and animals etc. Now a day in present life style a complete ban on the use of plastic cannot be put, but instead of it can used in road construction without any problem

II. LITERATURE REVIEW

1) *Dr. R. Vasudevan* states that the waste plastic blend in bitumen have a better binder compared to plain bitumen. Properties has increased physical properties of Softening point and decreased Penetration value with a suitable ductility. When it used for construction of road it can withstand higher temperature more than 50 and heavy load. The coating of waste plastics reduces the physical properties of aggregate likes porosity, water absorption and improves soundness. The plastic coated aggregate bitumen e mix shows higher Marshall Stability value and flow value. Hence the use of waste plastics in road construction is one of the best methods for easy disposal of waste plastics
2) *According to V.S. Punith,* (2001), some results were reported in this study that there is possibility to improve the performance of bituminous mixes of flexible pavement. Waste plastics soften at around 130°C. Thermo gravimetric analysis has shown that there are no toxic gases at temperature of 130-180°C. Softened plastics have higher binding property. Hence, it can be used as a binder in flexible pavement
3) *Zoorab and Suparma* reported the use of waste plastic in plain mix. Sabina et al. investigates the benefits of coating the aggregate by adding waste plastic it is improve the parameters of bituminous road with plastic coated aggregate.

III.MIXING PROCEDURE OF COATED AGGREGATE IN HOT MIX PLANT

A. Polypropylene was collected from recycled plants
B. It is clean and washing if required
C. Collected polypropylene Plastic was cut into fine pieces as far as possible. The plastic pieces were sieved through 4.75mm sieve and retaining at 2.36mm sieve was collected
D. Aggregate was heated at temperature about 160°c-170°c at a melting temperature

E. The shredded polypropylene plastics waste is added over the hot aggregate. It gets coated uniformly coat the aggregate within 30 to 45 seconds. It looks like oily coated aggregate.

F. The polypropylene plastics coated aggregate is mixed at temperature of 120℃ to 130℃ in bitumen .Then this final resulted mix can used in construction of road.

Advantages of Dry Process

1) It's improving physical property of aggregates.
2) Coating is easy & temperature required is same as road laying temp.
3) 15% of plastic are used in construction.
4) Flexible films and all types of plastic can be used.
5) The binding property of aggregates is improved
6) No special equipment is required.
7) The coated aggregates show increased strength.
8) No degradation of roads up to 4 to 5 years and no maintenance cost
9) It can be use in all type of climatic conditions
10) No evolution of any toxic gases.

IV. METHODOLOGY

A. Objectives of study

*1)*To coat aggregate by adding polypropylene
*2)*To determine the physical properties of bitumen and coated aggregate
*3)*Determination of optimum binder content to improve stability and flow value
4) To check the properties of bituminous mix specimen by Marshall Stability methods by adding different proportion of polypropylene by dry process

B. Tests for aggregate

1) Specific Gravity & Water Absorption Test
2) Aggregate Impact Value Test
3) Flakiness & Elongation Index Test

C. Test of bitumen

1) Penetration Test
2) Softening Point Test
3) Ductility Test
4) Specific Gravity Test

V. EXPERIMENT AND RESULTS

Srno	Test	Normal Aggregate%	Coated Aggregate%
1	Impact value	13.02 %	5.84 %
3	Water Absorption	0.97 %	0.45 %
4	Specific Gravity	2.94 %	2.07%
5	Flakiness Index	22.52 %	22.71 %
6	Elongation Index	24.13 %	29.14 %

Table 1 Comparison of Normal Aggregate and Coated Aggregate

Test	Normal Bitumin	IS Code	Specification Requirement
Specific Gravity	1.02 %	IS :1202 - 1978	1%
Penetration Test	95.1mm	IS: 1203 - 1978	80 to 100
Ductility Test	72 cm	IS: 1208 - 1978	75 cm
Softening Test	44.3°C	IS: 1205 - 1978	40 to 60

Table 2 Test results of Bitumen

A. Marshall Mix Design

In the Marshall Test method of mix design three compacted samples are prepared for different binder content. At least four contents of bitumen are to be tested to get the optimum binder content. There are three important criteria in Marshall :

1) Bulk density determination.
2) Stability and flow test.
3) Density and voids analysis.

The coarse aggregate, fine aggregate, and the filler material should be proportion as per MORTH specification. The required quantity of the mix is taken so as to produce compacted bituminous mix specimens of thickness 63.5 mm approximately. Take 1200 gm of aggregates and filler material are required to produce the desired thickness of specimen .The aggregates are heated at temperature of 175° to 190°C the compaction mould assembly and rammer are cleaned and kept pre-heated to a temperature of 100°C to 145°C. The heated aggregate and thoroughly mixed. The mix is placed in a mould and compacted with 75 numbers of blows. The sample is taken out of the mould after few minutes using sample extractor In conducting the stability test, the specimen is immersed in a bath of water at a temperature of 60° ± 1°C for a period of 30 minutes. It is then placed in the Marshall Stability testing machine and loaded at a constant deformation rate should be of 5 mm per minute until failure. The total maximum in KN (that causes failure of the specimen) is taken as Marshall Stability. The total deformation is units of 0.25 mm that occurs at maximum load is recorded as Flow Value. There should be only 30 seconds to removing the specimen from the bath and completion of the test

B. Properties of the mix

G_t = Theoretical specific gravity

$$G_t = \frac{w_1 + w_2 + w_3 + w_b}{\frac{w_1}{G_1} + \frac{w_2}{G_2} + \frac{w_3}{G_3} + \frac{w_b}{G_b}}$$

V_b = Percent Volume of Bitumen

$$v_b = \frac{\frac{G_b}{G_m}}{\frac{w_1 + w_2 + w_3 + w_b}{w_m}}$$

G_m = Bulk specific gravity

$$G_m = \frac{w_m}{w_m - w_w}$$

VMA = Voids in mineral Aggregate

$$VMA = v_v + v_b$$

V_v = Air Voids percent

$$V_v = \frac{(G_t - G_m)100}{G_t}$$

VFB = Voids filled in Bitumen

$$VFB = \frac{v_b \times 100}{VMA}$$

Bitumin content %	Stability KN	Flow value mm	G_t	G_m	V_v %	*VFB* %
4.5	10.58	2.40	2.46	2.36	4.08	70.82
5	11.28	3.06	2.45	2.34	3.74	74.50
5.5	12.43	3.36	2.42	2.35	2.87	80.72
6	10.19	3.75	2.40	2.34	2.49	83.92
6.5	9.45	4.04	2.37	2.33	1.80	88.65

Table 2 Test results of Marshall Stability method

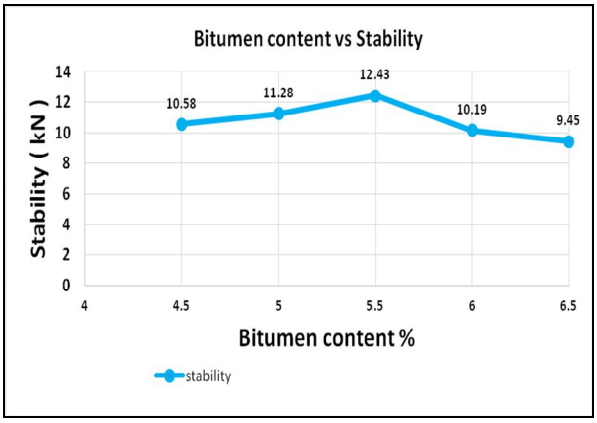

Fig. 1 Bitumen content vs Stability

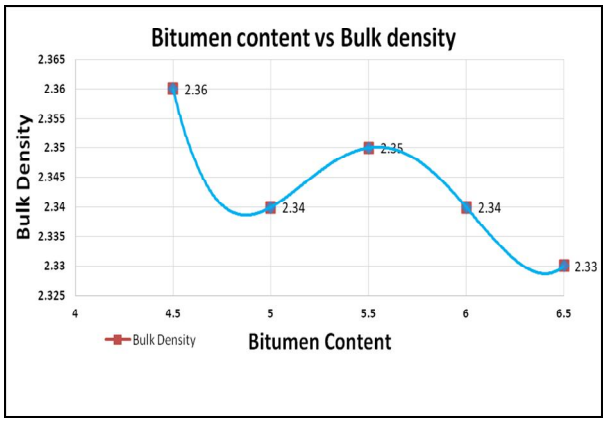

Fig. 2 Bitumen content vs Bulk Density

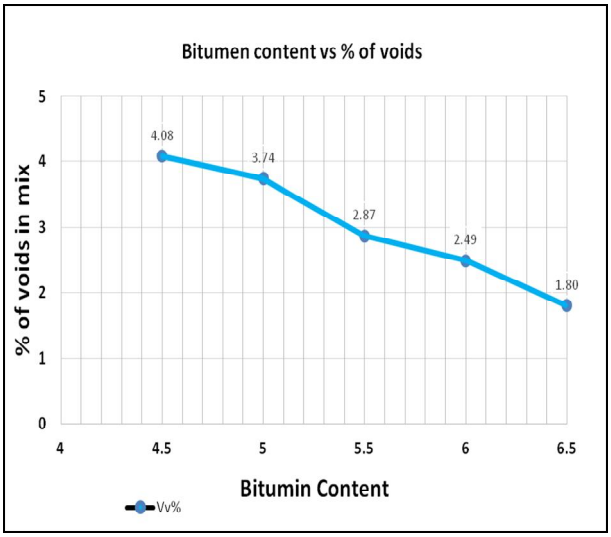

Fig.3 Bitumen content vs % of voids

1) Optimum Binder Content

Maximum stability of Bitumen Content = 5.5

Maximum Bulk density of Bitumen content = 4.5

Bitumen content at 4% of air voids = 4.565

Optimum binder content = (5.5 + 4.5 + 4.565/ 3) = 5.18

Take optimum binder content = 5.20 %

Bitumin content %	PP %	Stability KN	Flow value mm	G_t	G_m	V_v %	VFB %
5.20%	3	9.64	4.32	2.42	2.31	5.42	67.41
	5	11.22	4.22	2.42	2.32	4.98	69.34
	8	13.6	5.01	2.41	2.32	4.61	71.00
	10	15.22	3.62	2.40	2.33	3.70	75.49
	12	14.22	4.24	2.40	2.38	2.12	84.53
	15	12.20	2.64	2.38	2.3	1.90	85.52
	17	8.64	3.07	2.38	2.38	1.14	91.10

Table 2 Test results of Marshall Stability method by adding polypropylene

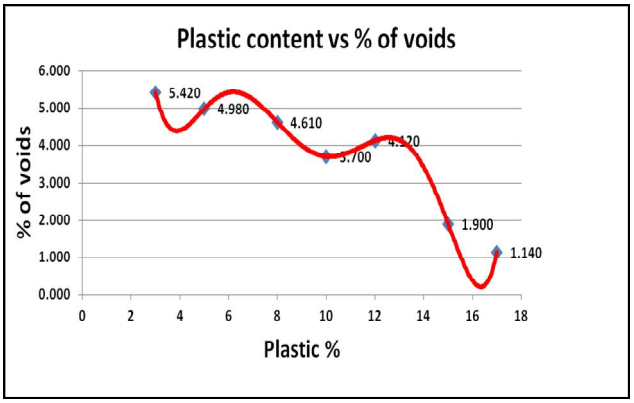

Fig. 4 Plastic content vs Stability

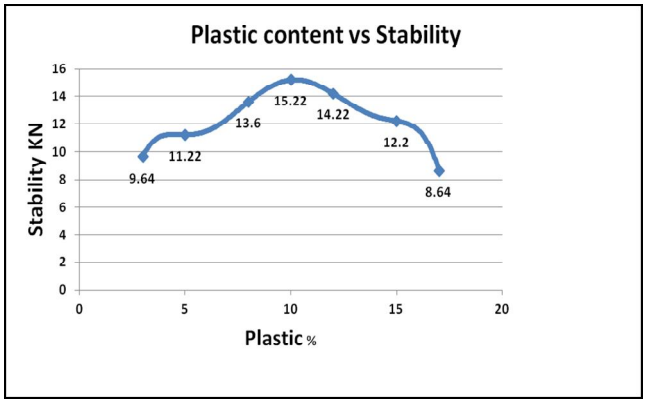

Fig. 5 Plastic content vs Stability

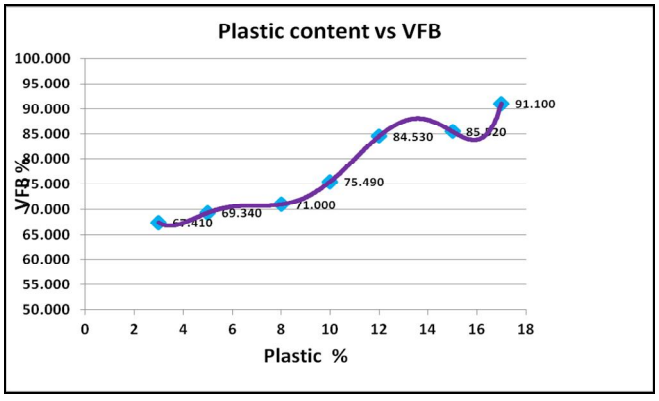

Fig. 6 Plastic content vs Stability

2) Optimum plastic content

Maximum stability of Plastic content = 10 %

VI. CONCLUSION

The results indicated that the consumption of Recycled Polypropylene in bituminous concrete mixtures shows improved property of the mixtures thus formed. The Polypropylene added to aggregate and will get coated over aggregates of the mixture and reduced physical properties of aggregate than normal properties accept specific gravity of aggregate .10% of plastic were added to coat the aggregate . The Marshall Stability which is a strength parameter has shown increasing trend up to 10 % after it was decreased Waste.

It is observed that Marshall Stability value increases with Polypropylene content up to 10 % and thereafter decreases. Thus the use of higher percentage of recycled polypropylene not preferable. While talking to environmental pollution due to these non biodegradable plastics waste where disposal of such materials has become a serious problem, so its use in construction of flexible pavement to solving the problem of their disposal on one hand and providing a better flexible pavement with improved performance on other hand. The physical properties of aggregates which mainly cause rutting action, which are improved using plastic coated aggregates. It increase in Marshall Stability value, Reduced air voids & the optimum bitumen content is also reduced.

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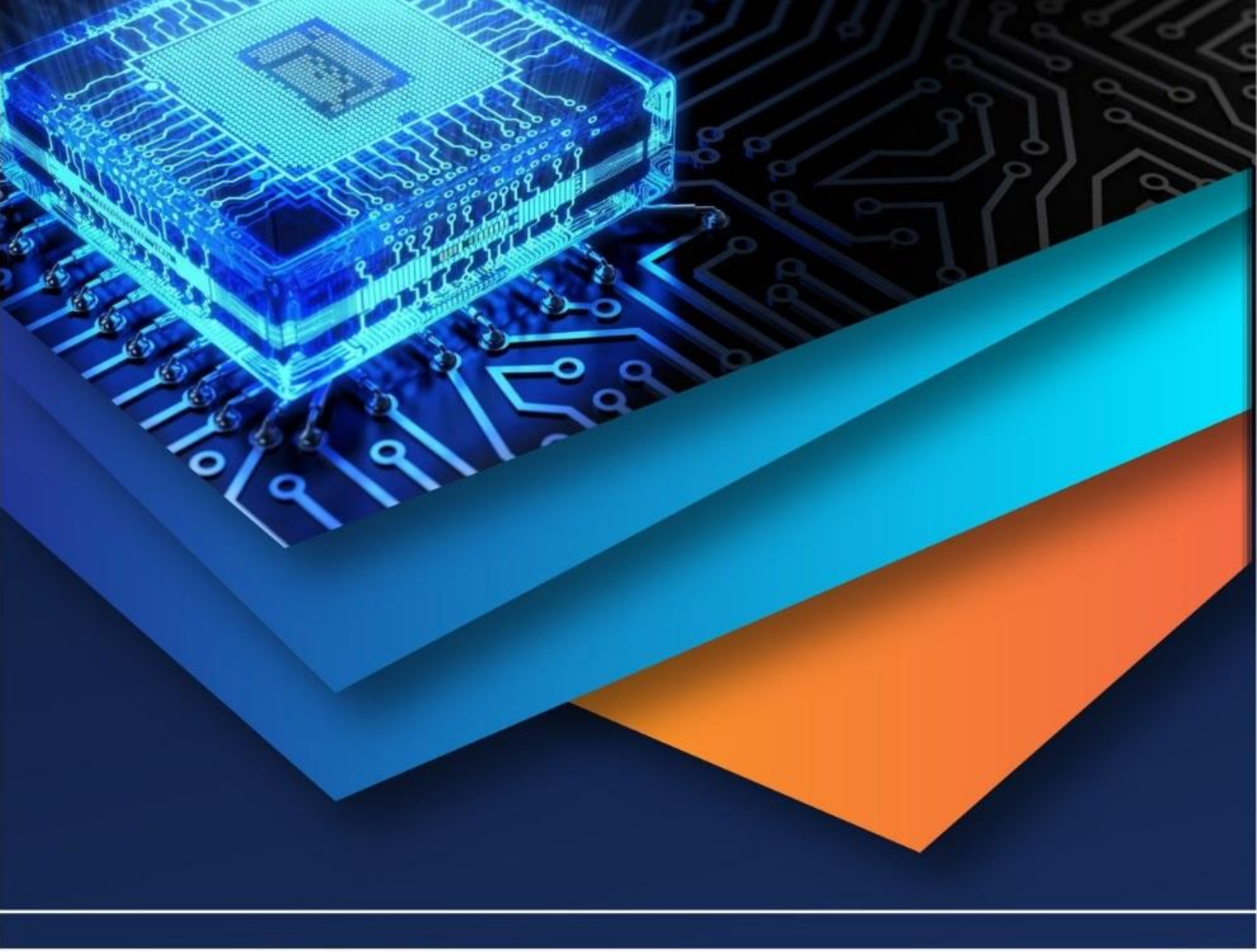

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