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Laboratory Performance Evaluation On Bituminous Concrete Mixes By Using Plastic Coated Aggregate.

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Abstract: One of the most influential ideas of the past several years is waste material management. Reusing waste materials in the construction of roads is necessary to overcome the plastic waste problem by leaps and bonds. Since plastic waste doesn't biodegrade, it poses a major environmental risk. The necessity to identify suitable solutions for efficient handling of plastic trash has been underscored by this issue. Natural resources are needed for the road building industry's rapid infrastructural growth. The cost of natural resources has increased recently, necessitating the repurposing of waste materials in road construction. Reusing waste materials is a fairly basic yet effective idea. Low Density Polyethylene (LDPE) is used in the construction of roads in this article. In order to cover stone aggregates, waste shredded plastic with a size range of 2 to 8 mm was utilized. For conventional aggregates and plastic coated aggregates (PCA), VG-10 grade bitumen was used in the Marshall mix design process. Marshall Specimens were prepared with waste plastic content of 0%, 16%, 17%, 18%, 19%, and 20% by weight of optimal bitumen content, and bitumen content ranging from 4% to 6% with an increment of 0.5% by weight of aggregates. The following parameters were measured and compared to standard aggregates (without plastic) bituminous concrete mixes: marshal stability, flow value, air voids (Vv), voids in mineral aggregates (VMA), and voids filled with bitumen (VFB). The use of plastic-coated aggregates was shown to reduce the amount of bitumen consumed in bituminous concrete mix and to significantly improve the qualities of both the bituminous mix and the aggregates

Index Terms **- Plastic-coated aggregates, Plastic waste, Marshal Stability, Flow value, Air voids.**

I. Introduction

"Plastic" refers to a substance made up of one or more extremely heavy-molecular-weight organic polymers that are thick when fully formed and, when manufactured into finished goods, can take on the shape of its flow. Plastics are resilient and break down very slowly; the chemical links that give plastic its strength also prevent it from breaking down naturally. Plastics can be categorized into two main groups: Thermoplastics Thermoset. When heated, a thermoset "sets," or solidifies, irreversibly. Because of their strength and durability, they are mainly utilized in construction and automotive applications. Polyethylene, polypropylene, and polyamide are these polymers. Due to the growing global population, improved demand for food and other necessities, and increased garbage generation by households, plastics have the ability to remain unmodified for up to 4500 years on Earth. It has been discovered that over 5% of municipal waste, which is naturally harmful, is made of plastic in various systems.

II.NEED FOR STUDY

One of the popular forms of transportation that was in use prior to the remarkable circumstances was the road.From then on, a lot of tests on pavement material were conducted to ensure that drivers could travel safely and comfortably.Given the current circumstances, it is expected that the road constructed with typical bituminous mixes will fail early due to its inability to handle the increased vehicular volume, frequency, and loading intensity.Numerous researchers have made contributions to the utiliization of waste materials to extend the lifespan of pavements. Stone matrix asphalt mix provides strong resistance to rutting characteristics and is appropriate for heavy vehicle usage.keeping in mind the ultimate objective of improving the SMA mixture's resilience and quality Arbocel Fibers is incorporated on a regular basis.

III. SCOPE AND OBJECTIVES OF STUDY

➢ The road network in India is growing daily, and bitumen combined with plastic is more durable than regular bitumen.

➢ Bitumen costs are high because adding plastic allows us to use less bitumen overall, which lowers construction costs.

➢ Now that plastic is used and the waste plastic is decreasing, the waste plastic is dumped on land and causes environmental problems.

➢ Building strong, long-lasting, cost-effective, and environmentally friendly roads is crucial. In each of these scenarios, the bitumen combined with plastic helps us achieve favorable outcomes.

1)To examine The_characteristics of waste plastic, bitumen, and aggregates.

2) To examine The_properties of aggregates coated with plastic.

3) To examine The_characteristics of bitumin mixed with and without waste plastic coating.

IV LITERATURE REVIEW

The expansion of many industry and population growth are the main sources of waste products. Plastic garbage is the kind of waste that harms the environment the most. The primary concern regarding plastic garbage is its inability to biodegrade. Recent research indicates that bitumen can acquire the desired mechanical qualities when it is varied with plastic trash. The main application for bitumen is in the building of flexible pavements. It enhances the water resistance, capacity, and stability of a mixture when combined with plastic waste. Its ability to function as a binder material in the bitumin mix for the production of flexible pavements has been demonstrated in laboratory tests. It is necessary to check the amount of plastic waste in bitumen. The most often utilized technique for transmitting under field conditions is the Marshal stability test. The samples that are utilized are composed of asphalt, or bitumen concrete, with varying percentages of bitumin and plastic content in each sample. The test findings are encouraging and provide room for more real-world implementations. Finding the ideal percentage of plastic debris that can supersede the bitumen level in the mixture is the test's main goal when designing flexible pavements. The main goal line of this research is to replace bitumen with plastic trash, a conventional and non-biodegradable substance. Brajesh Miishra*, M.K_Gupta*-The state of India's road network is deteriorating as a result of ongoing increases in traffic and inadequate maintenance brought on by a lack of funding. Better and more efficient roadway design, the use of higher-quality materials, and the application of contemporary and efficient construction techniques are all necessary to enhance adequate maintenance. It has been demonstrated over the last three years in numerous nations across the globe that adding polymer additives to the bituminous concrete binder enhances the characteristics and lifespan of the pavements made of bituminous concrete. The goal of the current study is to apply plastic coated aggregate (PCA) to bituminous mixes of flexible pavements to enhance their performance and provide a safe method for disposing of plastic waste to reduce environmental pollution. There are primarily two ways to include discarded plastic into bituminous mixes: that is, the wet and dry processes. Bituminous concrete mixes were processed using the dry method in this investigation. The traditional and plastic-coated aggregates' physical characteristics were contrasted. VG-10 grade bitumen was used for conventional aggrigates and plastic coated aggregates (PCA) in the Marshall technique of mix design. Marshall Specimens were prepared with waste plastiic content of 5%, 7%, 9%, 11%, 13%, and 15% by weight of optimal bitumen content, and bitumen content ranging from 4% to 6% with an increment of 0.5% by weight of aggregates. The following parameters were measured and compared: marshal stability, flow value, air voids (Vv), Voids in Mineral aggrigates (VMA), and voids filled with bitumen (VFB) with typical aggregates (without_plastic) bituminous concrete mixes. The use of plastic coated aggregates was found to reduce the amount of bitumen consumed in bituminous concrete mix. Additionally, the qualities of the bituminous mix and aggregates were significantly improved, resulting in longer pavement lifespan and improved pavement performance.

LITERATURE SUMMARY

The literature review led to the following clarifications. It is evident that the Marshall properties of Stone Matrix Asphalt mix are significantly influenced by the type of aggregate, binder, stabilizing agent, mixing, and compaction temperature.The aggregate bitumen bond gradually strengthens with an initial increase in bitumen concentration, but when bitumen content grows further, the applied load is conveyed as hydrostatic pressure, which keeps the portion across the aggregate contact point immobile. As a result, the mix becomes weaker against plastic deformation, and blends lacking fibers lose stability.In both mixtures with and without fibers, the flow value increases as the bitumin content rises.At first, the growth is gradual, but as the bitu-men content increases, the pace eventually increases as well. Mixtures containing fibers have a higher flow value than those that do not contain fibers at first. This could be because the fibers effectively fill in the voids in the bitumen at lower bitumen content, increasing homogeneity and providing the stability needed to withstand deformation under load. However, this homogeneity is lost when the bitumin content rises, and as a result, the binder property takes over and causes the fibers to lump together, decreasing stability and increasing deformation under load.It is clear from the literature review that SMA has more strength, longevity, and durability than conventional bituminous pavements. We can state with certainty that SMA is superior to many traditional mixes for a variety of reasons.

When compared to traditional alternative pavement surfaces, SMA offers superior resistance to rutting caused by slow, heavy, and high volume traffic. It also resists deformation at high pavement temperatures, enhances skid resistance, and lowers noise. SMA also boosts durability, decreases permeability and moisture sensitivity, and exhibits enhanced resistance to fatigue effects and cracking at low temperatures.

V MATERIALS TEST AND METHODOLOGY

SI.NO	MATERIALS	SOURCES
1	Aggregates	Narsareddy Plant Near Tuntapur Village Beside M-Sand Quarry , Raichur .
2	Bitumen VG30	Narsareddy Plant Near Tuntapur Village Beside M-Sand Quarry , Raichur .
3	Filler Cement	Narsareddy Plant Near Tuntapur Village Beside M-Sand Quarry , Raichur ..
4	Waste Plastic	BRB Circle , Raichur.

Table 5.1 - Selection of Aggregates

The materials employed in this dissertation study, specifically the coarse and fine aggregates, binders, filler material, and stabilizing additive, are the main topic of this chapter. Additionally, this chapter describes the several test procedures used to gauge the stability value, air void percentage, draindown potential, moisture susceptibility, and rutting features of stone matrix asphalt mix.Table 5.1 lists the resources utilized in this dissertation as well as their sources.

Table 5.2 - Test on Aggregate

Sl.No	Test	Result	Remarks
1.	Aggregate impact test	18.16%	Satisfactory As per IRC/MoRTH Specificatio ns
2.	Los angel’sabrasion value	15.58%	
3.	Aggregate crushing value	21.51%	
4.	Specific gravity	2.7	
5.	Elongation index	16.3%	
6.	Flakiness index	20.5%	

Table 5.3-Tests on VG10 Bitumen and Requirements

Sl No	Characteristics	Method	Requirements as per IRC:SP:53:2010
1	Penetration at 25℃,0.1 mm,100g, 5s	IS : 15462- 2004	30-50
2	Softening Point ℃, minimum	IS : 15462- 2004	60
3	Flash Point (℃)	IS – 15462-2004	Min 220
4	Specific Gravity	IS – 15462-2004	>0.99

FILLER MATERIAL

In place of 2% of the stone dust in the stone matrix asphalt mixture, hydrated lime has been employed as a mineral filler. It was purchased from Thimapurapet Road, Vijay Laxmi Enterprises, Raichur. According to MoRTH 500-36 section and IRC: SP: 79: 2008, the grading requirements are met. The required grading for mineral filler

WASTE PLASTIC

- Waste plastic must fit through a 2.36 mm sieve and be held on a 600 micron sieve.
- The maximum amount of dust and other contaminants is one percent. The steps involved are listed in Annexure-1. Finding the ash content at 600°C is a simple way to estimate the amount of impurities.
- To find out if plastic may combine with the binder, the melt-flow test should be performed in accordiance with ASTMD 1238-2010; the acceptable range for this examination is as follows: 0.14-58gm/10minforLDPE , 0.02–9.0 gm/10 min for HDPE
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Table5.4 - Correction_Factor for the Marshall Stability Values

SI NO	Volume of specimen,cm³	Average thickness ofspecimen, mm	Correction factors
1	457-470	57.2	1.19
2	471-482	58.7	1.14
3	483-495	60.3	1.06
4	496-508	61.9	1.04
5	509-522	63.5	1.00
6	523-535	65.1	0.96
7	536-546	66.7	0.93
8	547-559	68.3	0.89

9	560-573	69.8	0.86

NORMAL MIX

Table 5.5 - Correction Factor for Marshall Stability Test

Average Thickness ofSpecimen, mm	Correction Factor
57.2	1.19
58.7	1.14
60.3	1.09
61.9	1.04
63.5	1.00
65.1	0.96
66.7	0.93
68.3	0.89
69.8	0.86

VI EXPERIMENTAL PROGRAMME

MATERIALS

AGGREGATE PROPERTIES

The aggregates were evaluatied for various physical properties in accordance with the In- dian Standard specifications as shown in Chapter -5, Table 5.1. The following Table 6.1 presents the test results of physical charactieristics of aggregates used in the present dissertation work.

Description Of tests	Percentage of Plastic/ additive by weight ofOBC						Specifications IRC:1 11-2009
	0 %	16 % (PCA)	17 % (PCA)	18% (PC A)	19% (PC A)	20% (PC A)	
Aggregate Crushing value	17.10 %	11.23 %	9.76%	10.2%	10.25 %	10.3%	Max 30%
Impact value	14.33 %	10..95 %	10.64%	10.34 %	10.24 %	10.3	Max 24 %
Specific gravity value	2.64	2.69	2.82	2.85	2.85	2	2.5 - 3.0
Flakiness Index value	12.34 %	11.938 %	11.98%	12.3%	2.32%	12.35%	Max 35%

Elongation index value	11.2%	11.3%	11.35%	11.38 %	11.39%	11.40 %	Max 35%
Los Angeles Abrasion value	14.27 %	10.2%	9.8%	9.4%	9.5%	9.6%	Max 30 %

Table 6.1 Results of test performed on plain aggregate

Binder

Throughout the dissertation work, bitumen grade (VG -10) was utilized as the binder in the Stone Matrix Asphalt Mix combination design. Table 6.2 contains a tabulation of the test findings

Table 6.2 Results of test performed on bitumen

S.No	Test	Result	Remarks
1.	Penetrationtest	82 cm	Satisfacto ryAs per MoRTH Specificat io ns
2.	Ductility test	50-70 cm	
3.	Softeningpoint test	56°C	
4.	Specific gravi-ty test	0.99	
5.	Flash and firepoint test	180°C 210°C	

Mineral Filler

Finally split minerals, such as rock dust, hydrated lime, or cement, should make up the filler. Because hydrated lime has excellent anti-oxidant and anti-stripping qualities, its use is recommended. The table below displays the filler gradation

Table-6.3 Grading requirement of Mineral filler

IS sieve sizein mm	Cumulative_% by weight oftotal Aggregate passinig
0.6	100
0.3	95-100
0.075	85-100

Aggregate Gradation

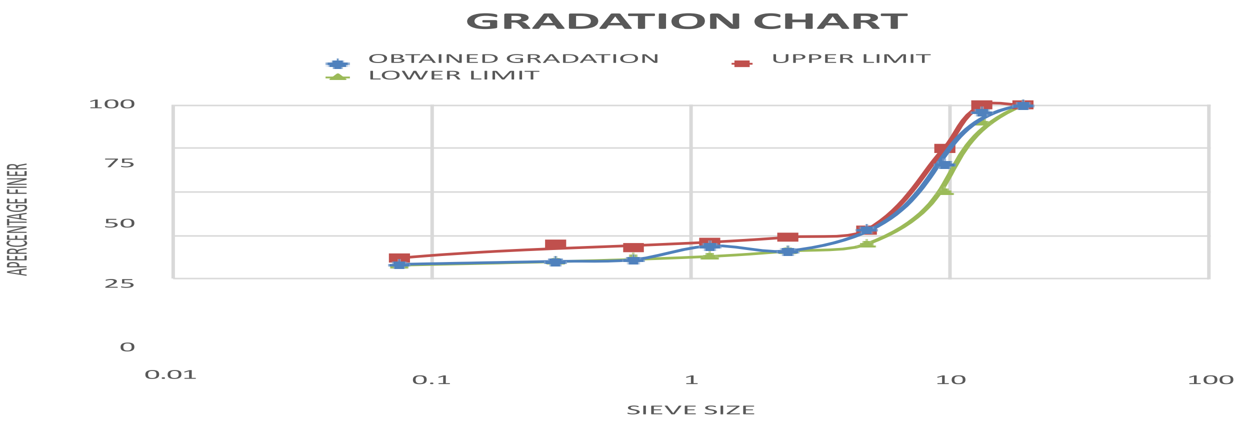


Figure 6.1 Gradation_Chart for HMA

Waste Plastic

Table 6.4 Properties of Waste Plastic

Property	Values
Size (Range) LDPE	2.36 mm - 600 µ
Density of (gm/cc)	0.91-0.94
Thickness in µ	10 µ -30 µ
Melting Temp. (in °C)	110-130

VII MIX DESIGN

Marshall mix Parameter for 0% of Plastic

% of Bitu-men	G_t	G_m	V_v %	VMA %	VFB %	V_b %	Stability Value (kg)	Flow Value (mm)
4	2.4	2.	5.04	14.15	64.39	9.11	8.27	2.56
4.5	2.47	2.64	4.85	15.14	67.95	10.28	8.72	2.9
5	2.42	2.36	4.06	15.66	74.06	11.60	11.42	3.12
5.5	2.39	2.64	3.42	16.14	78.79	12.71	9.76	3.36
6	2.38	2.63	3.03	16.85	83.04	13.82	8.31	3.59

Where, G_m = Bulk specific gravity, G_t = Theoretical specific gravity, V_v = Percentage air voids, V_b = Percentvolume of bitumen, VMA = Void in mineral aggregate, VFB = Voidsfilled with bitumen.

Marshall mix Parameter for different percentage of Plastic

% ofBitu-men	% of plastic	Gt	Gm	Vv %	VMA %	VFB %	Vb %	Stability Value (kg)	Flow Value (mm)
5	16	2.28	2.21	3.25	11.75	72.37	11.60	12.77	3.12
5	17	2.5	2.21	1.62	10.12	84.03	8.50	15.1	3.36
5	18	2.21	2.17	1.59	9.96	84.01	8.37	17.98	3.91
5	19	2.22	2.18	1.59	9.95	84.01	8.39	17.65	4.02
5	20	2.23	2.19	1.58	9.94	84.00	8.40	17.02	4.09

VII RESULTS AND DISCUSSIONS

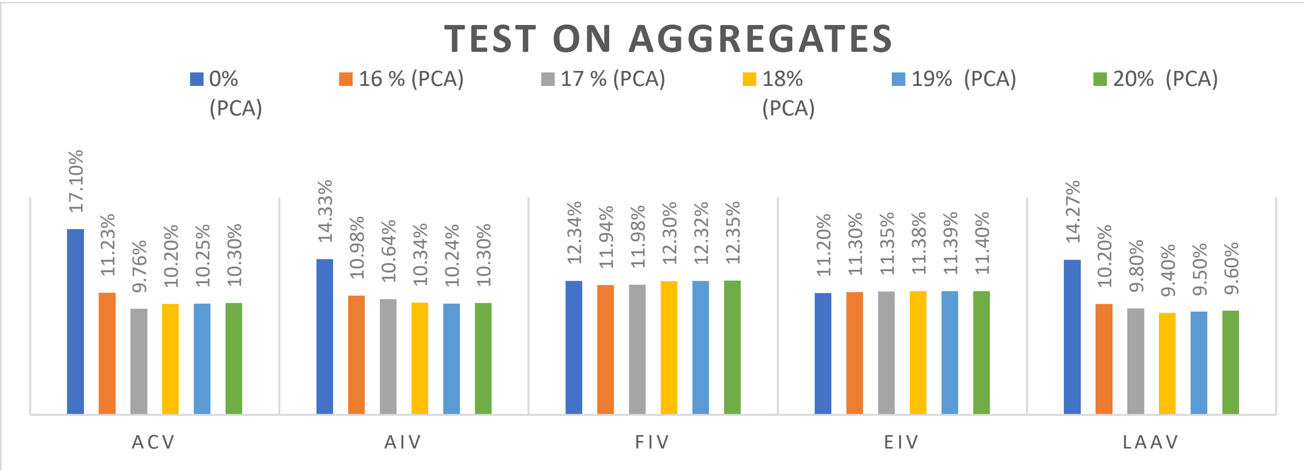
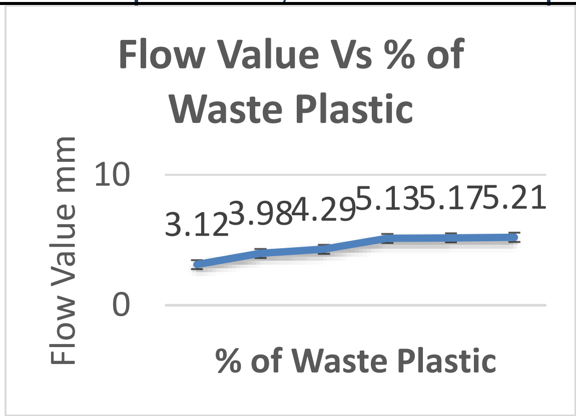
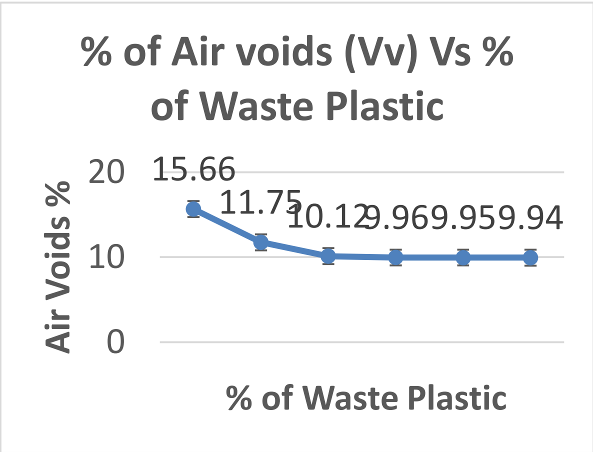


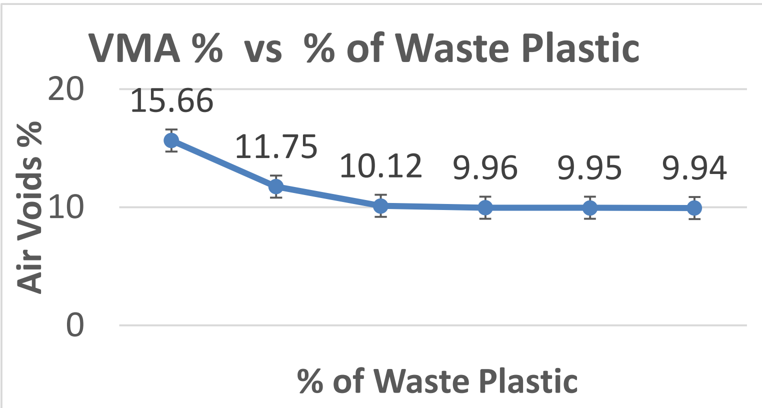
Figure 7.1 Graphical Representation of Test on Aggregate

Marshall Stability Test for 16%,17%,18% 19% and 20% Plastic

1. It has been noted that the bitumen pure mix Marshall Stability values were typically substantially higher than the bitumen stability values obtained.
2. Our experimental results reveal that a significantly higher Marshall Stability value is obtained when bitumen is added in smaller percentages to aggregate covered with plastic waste. It has also been distinguished that the amount of bitumen required for a suitable mix composition decreases with the addition of plastic. Additionally, it was distinguished that there were less air voids and more voids filled with bi-tumen.
3. After maintaining a 5% bitumen percentage, the amount of plastic waste coated over the varied and the Marshall Stability values were established for various samples. According to the experimental results, using polymer-coated aggregate may result in a lower minimum amount of bitumen needed for an efficient mix. The decrease depends on how much waste plastic is utilized to coat.







VIII CONCLUSION AND FUTURE SCOPE

Conclusion

Plain Aggregate and Plastic_Coated_Aggregate

1 Aggregate Impact value of control specimen was 14.33%. It reduced to 10.95% for 16.0% coating , 10.64% for 17% , 10.34% for 18% coating 10.24 for 19% coating and 10.30 for 20% coating. The average impact value significantly decreased as the coating percent was increased. This shows there is incirease in toughness property of aggregates.

1. Crushing Value of control specimen was 17.1%. At 1%, 16%, 17%, 18%, 19% , 20% coating crushiing value is 11.23%, 9.76%, 10.2%,10.25,10.30 respectively. Low aggregate crushing val- ue indicates strong aggregates, as the crushed fraction is low. Results showed that there is

not much changer in value on changingthe percenage of coating.

2. Los angles abrassion value reduced from 14.27% for control sample to 10.2%,9.8%,9.4% ,9.5%,9.6% at 16% ,17%,18%, 19% , 20% respectively.
3. Flakiness Index value reduced from 12.34% for control sample to 11.93%,11.98%,12.3% ,1232,12.35 at 16% ,17%,18%,19% , 20% respectively.
4. Elongation Index value value reduced from 11.2% for control sample to 11.3%,11.35%,11.38% ,11.39%,11.40% at 16% ,17%,18%,19% , 20% respectively.
5. Tests are performed on normal aggregiates as well as on plastic coated aggregates (PCA) and results were compared with _IRC/MORTH_specifications as given below. As we can see from the that aggregates were good to be used for pavement construc- tion but other aggregates of poor quality can also be used and by coating it with op- timal plastic content 0%, 16%,17%, 18%,19% and 20% its strength can be increased as given in Graph.

Future Scope

1 In this project, VG30 grade of bitumen was used. Hence, other grades of bitumen canalso be used for the same bitumen mix design to gain better results than VG30 grade ofBitumen.

2. Above analysis are based on the bituminous Concrete mix , hence one can change thepavement type and can see what possibly the results.
3. Number of test that have been used to prove the suitability of PCA can be increased and additional test like water absorption, stripping value, etc. can also be used to obtain betterresults and reliability.
4. As in this project, 18% plastic coating was proven to be optimum but percentage near to 5% can also be tested to get more accuiracy and same goes with determination of opti- mum bitumen content.
5. During coating of aggregates with plastic, eggshell powder can also be mixed to impartcertain drainage and other properties to the aggregates which will be helpful for road mainteniance

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