EVALUATION OF MECHANICAL PROPERTIES OF SDBC WITH WASTE PLASTIC

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Abstract: **Bituminous mixtures are widely used throughout the world to build flexible paving. Asphalt or bituminous (which is used as a binder) and mixed minerals, laid out in layers and then compacted. In normal situations, if ordinary pavers are properly designed and run properly, bituminous mixing performance is in very poor condition. Today's asphaltic concrete pavements are better, due to the increase in traffic volume, the variations in the current or seasonal temperatures have increased and over the past. In addition, the performance of bituminous flooring is very scarce in humidity conditions. This strange work has been done on the use of bituminous mixtures and on the modification of bitumen. Research has shown that asphalt binders add polymers to the interaction between the aggregate and the cement to increase cohesion, to improve the properties of asphalt pavements to achieve greater demands. However, the additives that must be used to change the mixer or binder meet the requirements and financial aspects of the mixer.**

The basic properties of aggregates and bitumen are found by conduction laboratory experiments. Later Later the Aggregate gradation required for Semi Dense Bituminous concrete is prepared as per MoRTH guidelines, SDBC grading I is selected for this dissertation work. For convention SDBC mix optimum bitumen content is determined using Marshall Stability Test. For obtained optimum bitumen content. Then the rheological properties bitumen modified by waste plastic is determine and the properties aggregate coated with waste plastic is also determined. Then new mix of SDBC is prepared with different percentage of waste plastic. For this dissertation work a proportion of 2%, 4%, 6% 8% and 10% of different percentage of waste plastic coated with aggregates mix is prepared and mix strength is determined using Marshall Stability Test. Also, other marshall properties such as flow value, bulk density VFB and VMA is analysed. For the mix with maximum strength and minimum strength is analysed for its performance evaluations using Immersion Wheel tracking equipment. From this dissertation work it is observed by adding plastic to the unmodified bitumen, the rheological properties have been improved and by using plastic as a coating over aggregates, the properties of aggregates are improved. In SDBC mix with waste plastic of 8% has the higher strength than conventional mix. Coming to performance evaluation 8% of waste plastic mix has more rutting resistance potential than the conventional mix.

Key words: Hot mix asphalt, Semi Dense bituminous concrete, Marshall stability test, immersion wheel tracking test, waste plastic.

I. INTRODUCTION

In the recent years industrial development and rapid urbanization has lead to generation of huge quantity of solid waste and environmental pollution. Solid waste management has emerged as major issue of concern for environmental engineers now a days. Due to improper dumping of this waste material, environment is getting polluted to large extent and hence, there is an urgent need to reuse and recycle this waste into useful forms.

India has the second largest road network of over 4,6 lakh KM in the world. Due to extreme climatic conditions, traffic growth and increased maintenance costs on roads in India, it is necessary to develop sustainable technologies and cost-effective road construction. Since the construction of the highway involves a huge amount of money, the appropriate engineering design and the use of waste materials in the construction of highways can save significant costs. It should be noted that the main part of the highway in India is flexible. Several studies have shown that permanent deformation within a flexible pavement is usually limited to the upper 100 to 150 mm pavement, also referred to as the surface flow

Unfortunately, plastic non-biodegradable material stays in the environment for hundreds of years and causes waste disaster crisis and various environmental concerns. One solution to this crisis is to recycle waste as useful products. Polyethylene is widely used in plastic materials, and is the most effective polymer in road construction One of the additions. In recent years, the cost of bitumen in India has grown rapidly due to the increase in crude oil prices. Study studies should note that in India, NH offers only 2% of the total road network but 40% traffic congestion but plastics are not used in any SH and NH in India.

II. SCOPE AND OBJECTIVE OF THE STUDY

To evaluate mechanical properties of semi dense bituminous concrete with waste plastic

a) To study the physical properties of aggregate

b) To study the physical properties of bitumen (VG30) and compare with bitumen modified with waste plastic.

c) To determine the strength of SDBC for different waste plastic proportion using Marshall Mix Design process.

d) To design the thickness of Semi Dense Bituminous concrete mix.

e) To determine asphalt deformation using immersion wheel tracking.

f) To analyze and compare the costs of mixes.

III. MATERIALS USED IN THE STUDY

I. AGGREGATES:The aggregates selected for the Semi Dense Bituminous concrete are subjected to various aggregate tests as specified by IRC: SP: 79: 2008 and MoRTH section 500, confirming to the table 500-14. Good durable quality crushed aggregates of different sizes are obtained from quarry Q-con near Mandya.

Table 1: Properties of Coarse Aggregates

SI NO	Aggregate tests	Standard results as per MORTH-500
1	Aggregate Impact Test	Max 27%
2	Specific Gravity	2.5-2.7
3	Flakiness index Elongation index Combined index	Max 30%
4	Abrasion test	Max 35%
5	Water Absorption	Max 2%
6	Crushing strength	Max 30%

I. BINDER:.Bitumen (VG-30) was used as the binder in the mixture design of Semi Dense Bituminous concrete Mix throughout the dissertation work.

Table 2: Properties of Bitumen

SI NO	Test Method	Standard results MoRTH-500 (IS:73)
1	Specific gravity test	1.02
2	Penetration test	Min 45 mm
3	Ductility test	Min 40 mm
4	Viscosity test	30 centi poise
5	Softening point test	45°c-55°c

II. **MINERAL FILLER***:* The Stone dust has been used as the mineral filler in the Semi Dense Bituminous concrete grading requirement of mineral filler are followed as given in MoRTH-500. The gradation requirements of mineral filler are given in Table 3.

Table 3: Gradation details of Mineral Filler

IS SIEVE (mm)	Cumulative per cent passing by weight of total aggregates
0.6	100
0.3	95-100
0.75	85-100

IV. RESULTS AND DISCUSSION

A. Aggregates The aggregates were evaluated for various physical properties in accordance with the Indian Standard specifications. Table5 represents the test results of physical characteristics of aggregates used in the present dissertation work.

B. Binder Bitumen (VG-30) was used as binders in the mixture design of Semi Dense Bituminous concrete Mix throughout the dissertation work. Table6 gives the experimental results.

C. **Mineral filler** The Stone dust has been used as the mineral filler in the Dense Bituminous mixture
D. **Additive** waste plastic has been used.

Table 4: aggregate test results

SI NO	Aggregate tests	Results
1	Aggregate Impact Test	20.8%
2	Specific Gravity	2.6
3	Flakiness index Elongation index Combined index	13.80% 13.62% 27.42%
4	Abrasion test	24.81%
5	Water Absorption	0.2%
6	Crushing strength	28.46%

Table 5: Bitumen test results VG-30

SI NO	Test Method	Results
1	Specific gravity test	1.02
2	Penetration test	65mm
3	Ductility test	94mm
4	Viscosity test	30 centi poise
5	Softening point test	49°c

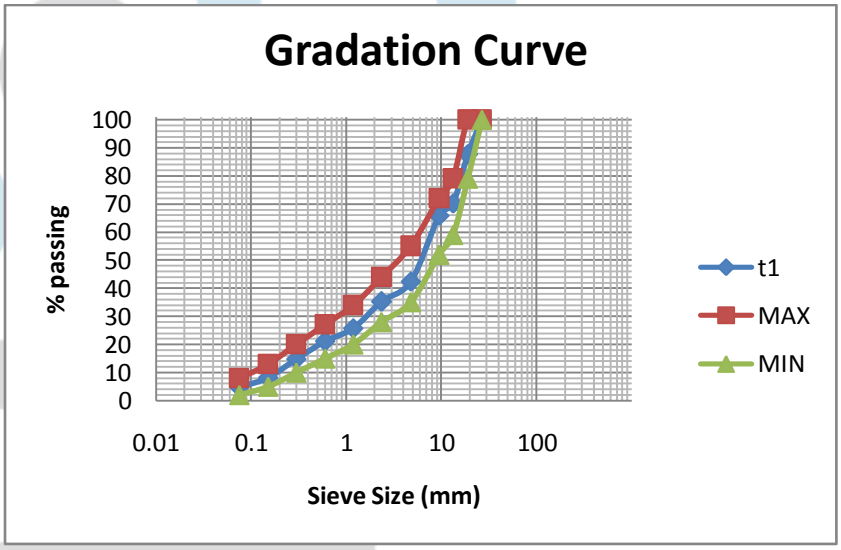
E. **Aggregate Gradation**

After the basic tests, the aggregates are further used in the determination of the proper blend to give a good mix consisting of different size of aggregates.The aggregate gradation is done by using Job Mix Formula Method to find the individual percentages of different sized aggregates to be used confirming to the upper and lower limits specified as per MoRTH table 500-10 grading-2. The gradation of aggregates for DBM-grade2 mix as shown in Table 7

Table 7:AGGREGATE GRADATION

Material A: 19mm-12.5mm: 35%
Material B: 12.5mm-2.36mm: 23%
Material C: 2.36mm-0.075mm: 40%
Material D: 0.075-PAN : 2%

MoRTH specification			
Upper limit	Lower limit	Middle limit	Trail mix
100	100	100	98
100	79	89.5	88
79	59	69	70
72	52	62	60
55	35	45	46
44	28	36	35
34	20	27	28
27	15	21	20
20	10	15	15
13	5	9	9
8	2	5	4

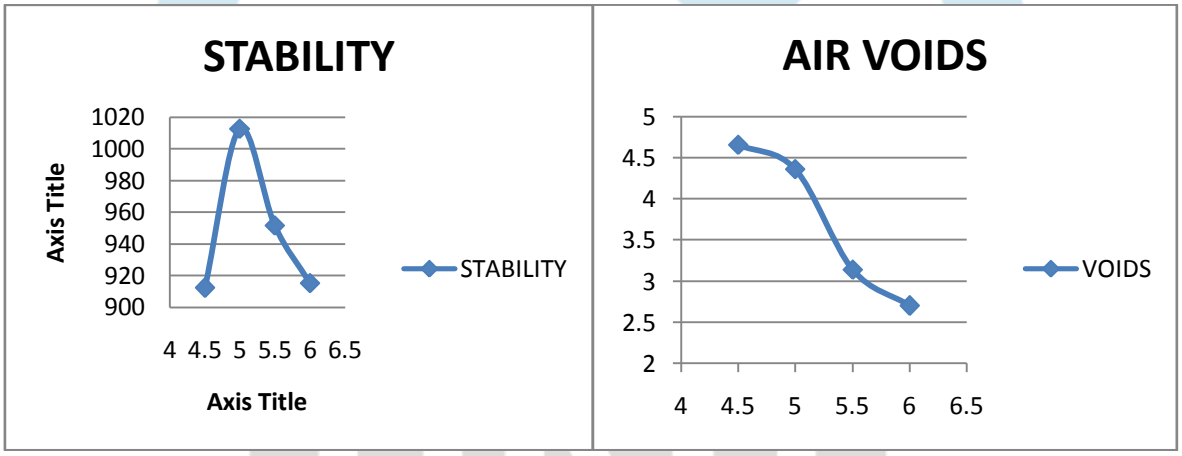


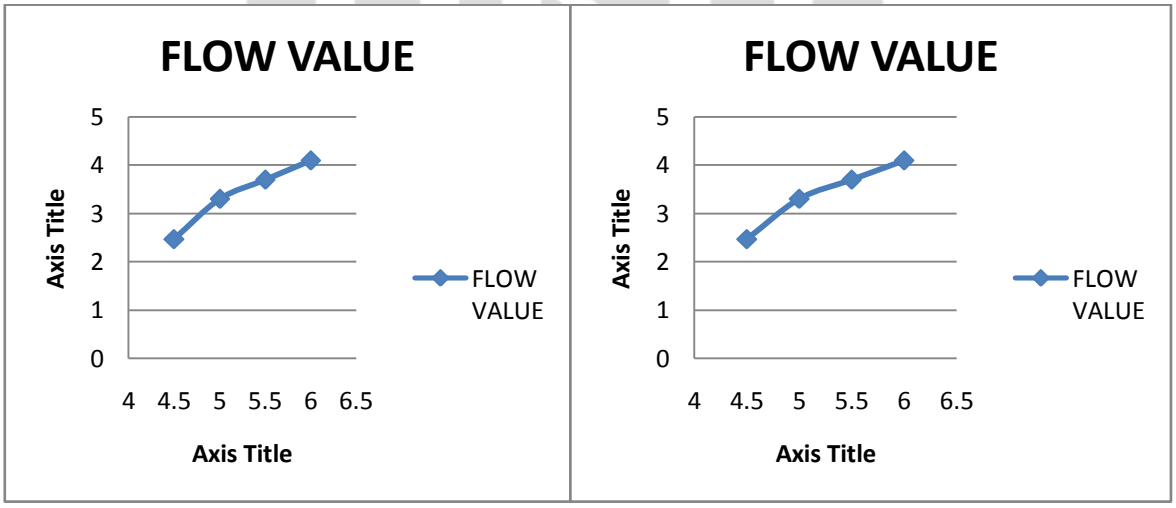
F. **Marshall Stability Test for various paving mixes**

. Following tables gives the average Marshall stability values for different paving mixes.

Table 8: Marshall Stability results of VG-30 paving mix

% of Bitumen	4.5%	5%	5.5%	6%
G_t	2.38	2.36	2.34	2.32
G_m	2.262	2.264	2.265	2.25
Density	2.263	2.264	2.266	2.257
V_v%	4.89	4.06	3.44	2.7
VMA%	14.88	15.16	15.66	16.00
VFB%	67.08	73.18	78.02	82.91
V_b%	9.98	11.09	12.2	13.3
STABILITY VALUE (Kg)	980.5	1121.4	1031.34	915.34
FLOW(mm)	2.47	3.3	3.8	4.7
CORRECTED STABILITY (Kg)	912.18	1012.62	951.48	915.33



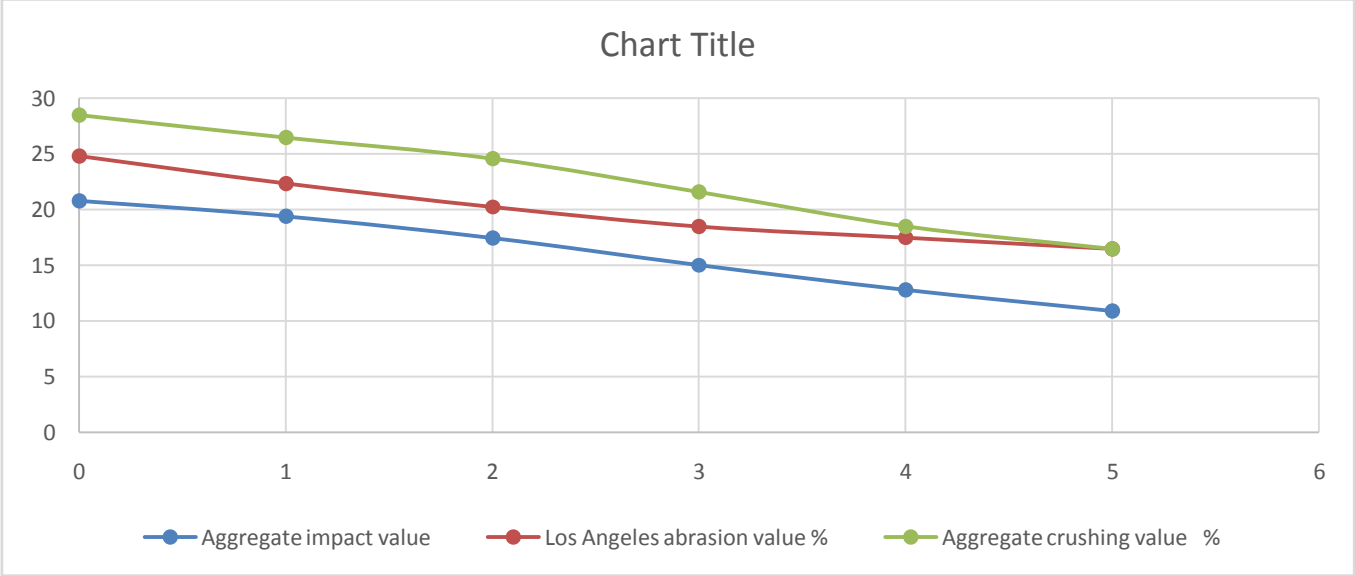


G. Properties of aggregate coated with waste plastic

The properties of Aggregate have been increased by the expansion of plastic as a covering over aggregate by expanding the level of plastic and results were arranged in Table 9. The outcomes demonstrate that there is an increase in the properties of aggregate. There is a change in affect in aggregate impact value, Los Angeles abrasion and total aggregate crushing vailue. Graph demonstrates the chart between % of plastic and total properties.

Table 9 Properties of aggregate coated with waste plastic

% of plastic coated with aggregate	Aggregate impact value (IS-2386 (part- IV)-1963) %	Los Angeles abrasion value IS-2386 (part- IV)-1963) %	Aggregate crushing value IS-2386 (part- IV)-1963) %
0	20.8	24.81	28.46
1	19.4	22.34	26.44
2	17.45	20.22	24.56
3	15.01	18.45	21.57
4	12.78	17.45	18.5
5	10.88	16.44	16.48

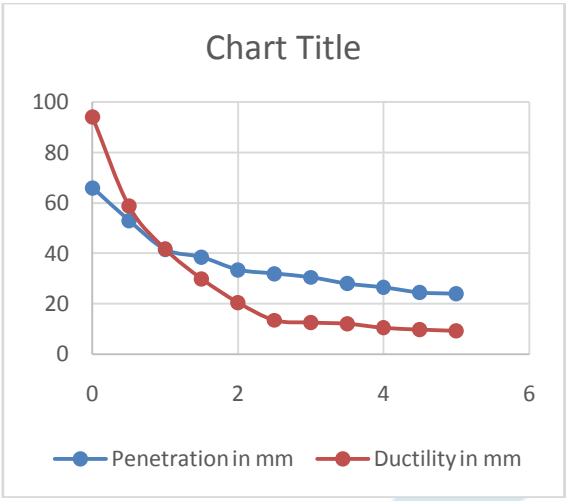


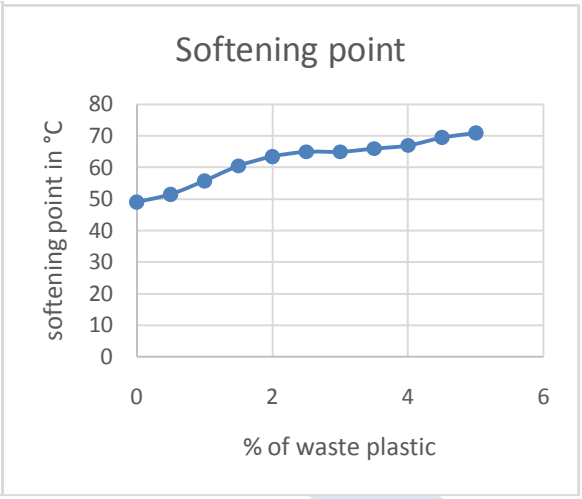
H. Test on bitumen modified by waste plastic

The properties of waste plastic–asphalt binders were evaluated such as softening point, ductility, penetration test and the results are presented in Table 10. The results indicate that waste plastic is effective in improving the rheological properties of asphalt . Examining Table 10, it can be seen that there is an increase in softening point and decrease in penetration and ductility values. below graph shows the comparative graph between % of plastic and properties of bitumen.

Table 10 Test on Bitumen Modified by waste plastic

% of waste plastic	Penetration in mm	Ductility in mm	Softening point
0	66	94	49
0.5	53	58.7	51.5
1	41.5	41.6	55.8
1.5	38.5	29.8	60.5
2	33.5	20.4	63.5
2.5	32	13.4	65
3	30.5	12.5	65
3.5	28	12	66
4	26.5	10.4	67
4.5	24.5	9.7	69.5
5	24	9.2	71





I. Marshall stability test for different percentage of waste plastic

The Marshall specimens are prepared with different percentage of waste plastic (2%, 4%, 6%,8% and 10%) The blending of the mix remains same as of the conventional mix but the optimum bitumen content of 5.18% is maintained. For every proportion of waste plastic three samples is prepared and average stability value is considered. In this dissertation work it is observed that the waste plastic of 8% will give the maximum stability value. the table 4.7 show the property of SDBC mix with different percent of waste plastic

Table 10:Marshall properties of SDBC mix with different percentage of waste plastic

% of waste plastic	OBC	Stability (kg)	Flow(mm)	VMA	VFB	Air voids(%)	Density (gm/cc)	Gt	Gb	Vb
0	5.18	1008	3.5	15.23	73.24	4.00	2.264	2.355	2.263	11.22
2	5.18	1039.9	3.7	15.67	72.12	4.01	2.266	2.377	2.261	11.31
4	5.18	1052.7	3.8	15.48	72.82	4.12	2.262	2.371	2.266	11.46
6	5.18	1061	3.9	15.88	71.22	4.18	2.263	2.378	2.266	11.52
8	5.18	1123.1	4.2	15.02	72.8	3.98	2.261	2.370	2.267	10.52
10	5.18	1109.5	3.7	15.47	71.56	4.05	2.264	2.377	2.260	11.02

Immersion wheel tracking The test results of rutting for 40mm thickness specimens for conventional, VG-30 paving mix with optimum waste plastic content and reduced thickness with 35mm with optimum bituminous content. The graphical representation of Rut depth v/s Number of Passes for 40mm and 35mm thickness specimen.

Table 11: Immersion Wheel Tracking Characteristics

Thickness	40mm
Type of Moulds	• Conventional Mould • 8% of waste plastic as additive in VG30 Paving Mix • 8% of waste plastic with reduced thickness (35mm)
Binder Content	VG-30
Tyre Pressure	7.2 Kg/cm^2
Speed of Wheel	25 Passes per Minute

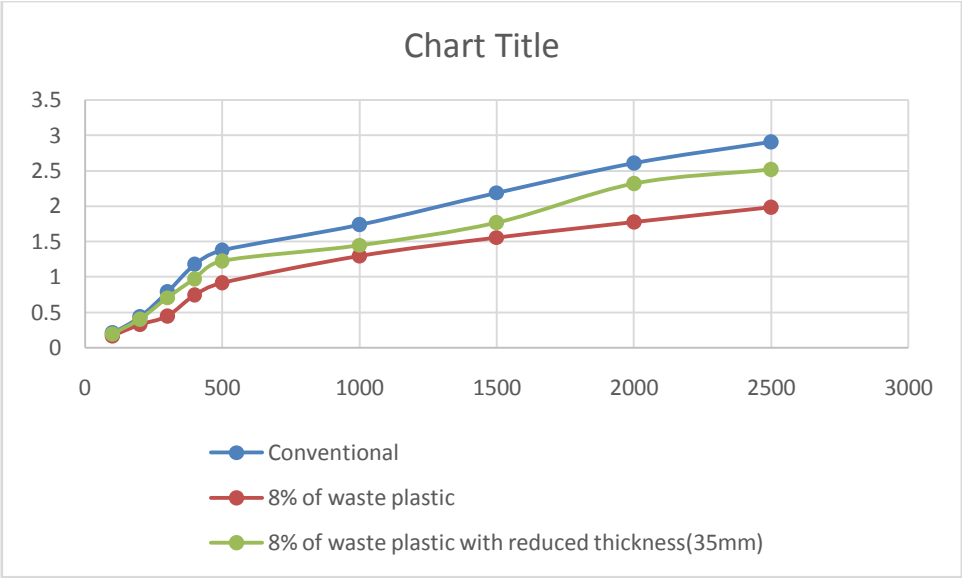


Fig 5: Rutting Characteristics for Various Mixture of 40mm thickness

Cost analysis of Bituminous Coarse

Cost analysis for bituminous pavement is done with road details include length of 1000m and carriage width of 5.5m for varying depth between conventional VG-30 SDBC mix of thickness 100mm(SDBC=40mm, DBM=60mm)

Table 12: Estimated cost of various paving mix

Sl no	Type of paving mix	Estimated cost(lakhs)
1	VG-30	Rs63,61,287
2	VG-30 with 8% of waste plastic	Rs61,46,567

CONCLUSIONS

The followings are the conclusions based on test results:

A. The aggregates and binder content test results are well in conference with specifications as per IRC: SP: 79: 2008.

B. The stability of the Marshall mix with different proportion of bitumen shows the good results against the minimum Marshall strength of 900Kg.

C. By using plastic as a coating over aggregates, the properties of aggregates are improved. This shows that weak aggregates can be used in construction by using plastic as a binder material.

D. By adding plastic to the unmodified bitumen, the rheological properties have been improved. There is an increase in the softening point and decrease in penetration and ductility values. The decrease in penetration value which indicates the hardness of the bitumen.

E. By increasing the percentage of plastic, the stability values are increased to and it gives the maximum stability when 8% of waste plastic is added

F. In the performance evaluation i.e Immersion wheel tracking test conventional mix have the rut depth of 2.91mm by the end of 2500 passes whereas mix with maximum stability of 8% waste plastic develop rut depth of 1.99mm there by the rut depth is reduced by 32% in 8% waste plastic than of conventional mix.

G. Also the mix 8% of waste plastic with reduced thickness has the rut depth of 2.52mm there by 13% of rut depth is reduced than that of conventional mix.

H. By adding the 8% of plastic to the mix we can reduce the construction cost up to 2 lakhs by reducing the thickness

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