Effect of PVC Waste and Replacement in Construction of Flexible Pavement

Saurav Kumar, R.K. Pandey, Sanjeev Singh, Neha

Abstract:* Bituminous pavement concrete is composite material used in construction of road pavement, airport runway and parking. It contains bitumen and aggregate mixed together, laid in layers and compacted. The steady increment in highway traffic volume density and remarkable variation in daily and seasonal temperature causes rapid detoriation and failure of pavement surface and course. Looking into the pavement condition it is worth to think of some admixes to be used for modification in constituents and mixture which must satisfy strength and economical aspects. It is worth to note that increased use of PVC in society is raising serious environmental issues; I have tried to mix PVC waste with bitumen for preparation of pavements as a little solution for the environmental pollution. The bituminous concrete mixes prepared with defined volume of PVC and aggregate as per the codes of IRC were used to prepare samples for testing. The samples were tested for Marshall Properties like stability, flow volume, unit weight, air voids etc and the optimum PVC content for the choosed bitumen (80/100) were achieved.

Keywords: Bituminous, pavement, (80/100), PVC, Properties like stability, Looking, IRC, volume, modification

I. INTRODUCTION

1.1 General

The danger of disposal of plastic will not be resolved until the serious steps are initiated at the ground level. The use of plastic waste as recycled plastic i.e. polyethylene, as blended form reduced the cracking of pavement surface. It has been proved that the properly processed used of plastic waste as additive would enhance the roads life and resolving environmental problem. versatile material i.e plastic due to industrial revolution and large scale production made it cheaper and effective raw material .today every sector i.e. electronic, automobile, building construction, agriculture plastic is playing a vital role .it is non biodegradable, material and can remains as it is under the earth for 4500 year without degradation but in case of health it is proved that the improper disposal is health hazardous. It caused various problems such as reproduction, defects genital abnormalities in human and animals. The waste plastic is like evil for present and future generation also. Banning of plastic is not easy task but the proper reuse of plastic waste is a solution. The municipal solid waste is of great concern. The proper ideas of reuse of plastic waste is need of hour.

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On other side the increasing traffic another issue we are facing hence the increase is load bearing capacity of pavement surface is important to counter the maintenance cost and time. So the use of plastic waste as additive to the bitumen mix is a solution to the both part i.e., plastic waste and pavement .plastic is versatile packing carrying material used these days commonly but they are creating problem to the environment. Mostly used plastic are made up of polyethylene, polypropylene and polystyrene. The 55% plastic are used in packing purpose. These are mostly dropped or left to the litter the environment after use. After mixing up with household waste plastic make municipal solid waste disposal a tough task. This waste are left on earth which becomes caused of air, soil and water pollution .if these waste are burnt they produce toxic gases. Thus the innovative use of plastic waste is the only solution is a eco friendly and can promote value addition to waste plastic.

Table 1: Municipal Solid Waste in Indian Cities

Population Range (Millions)	Average Per Capita Value (Kg)
0.1-0.5	0.21
0.5-1.0	0.25
1.0-2.0	0.27
2.0-5.0	0.35
> 5	0.50

Table 2: Plastic Consumption in India

S. No.	Year	Consumption (Tones)
1.	1996	61,000
2.	2001	4,00,000
3.	2006	7,00,000
4.	2011	13500000

Table 2 provides the data on total plastics waste consumption in India during last decade.

1.2. Pavement

The surface of roadway should be stable and non-yielding ato allow the heavy wheel load of traffic to move with least rolling resistance. To overcome these issue the stable and even surface for the traffic, the roadway is provided with suitably designed and constructed pavements structure.

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Fig.1.1 Bituminous Pavement

Bituminous binders are widely used by paving industry. A pavement has different layers. The main constituents of bituminous concrete (BC) are aggregate and bitumen. Generally, all the hard surfaced pavement types are categorized into 2 groups, i.e. flexible and rigid.

1.3. Flexible Pavement

If the surface course of a pavement is bitumen then it is called "flexible" since the total pavement structure can bend or deflect due to traffic loads.

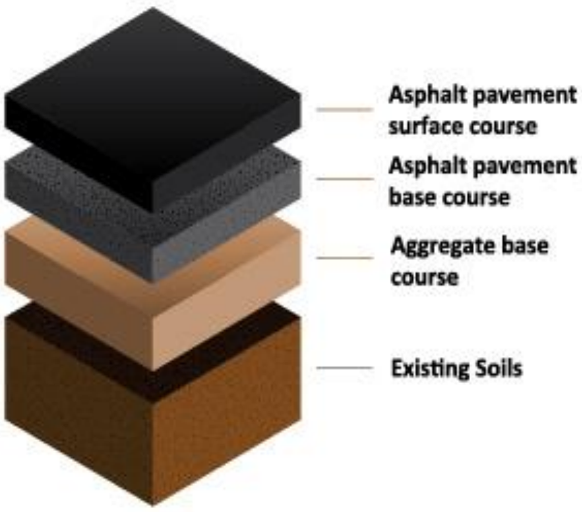

Fig. 1.2 flexible pavements layer

Overall if the surface course of a pavement is bitumen then it is called flexible pavement since the total pavement structure can bend or deflect due to traffic loads.

1.4. Rigid Pavement

Rigid pavement are those which posses noteworthy flexural strength or rigidity, stress are not transferred from grain to grain to the lower layer as in case of flexible pavement. Rigid pavements are made of Portland cement concrete –either plain, reinforced or prestressed concrete.

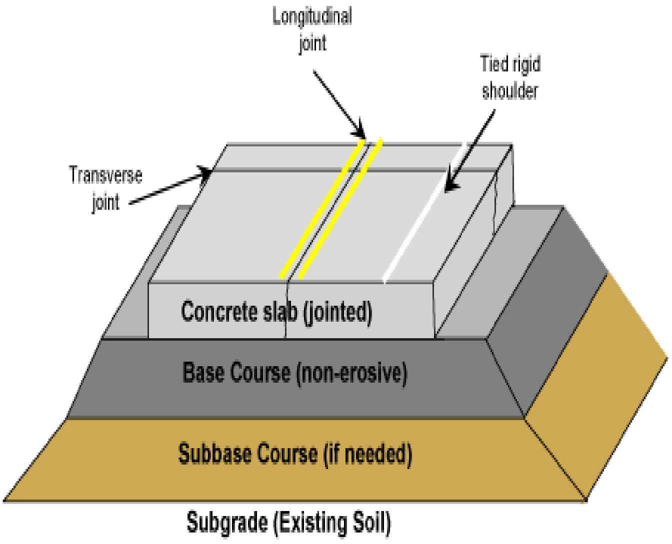

Fig. 1.3 Rigid pavement layer

If the surface course of a pavement is PCC then it is called "rigid" since the total pavement structure can't bend or deflect due to traffic loads . Such pavements are much stiffer than the flexible pavements due to the high modulus of elasticity of the Plain Cement Concrete material. Importantly, we can use reinforcing steel in the rigid pavements, to decrease or eliminate the joints.

1.5. Mix Design

Overview

Mix design should aim at an economical blend, with proper gradation og aggregates and adequate proportion of bitumen so as to fulfill the desire property of the mix. Bituminous concrete or asphaltic concrete is one of the highest and costliest type of flexible pavement layer used in the surface course. The desirable properties of good bituminous mix are stability, durability, flexibility, skid resistance and workability Construction of highway involves a huge outlay of investment. An accurate engineering design can save considerable investment; as well, a reliable performance of the highway, can be achieved.

Objectives of mix design

The bituminous mix design aims to estimate the proportions of bitumen, filler material, fine aggregates, coarse aggregates & polythene to produce a mix which should have Sufficient workability so that there is no segregation under load Enough strength to survive heavy wheel loads & tyre pressures.

These are objectives of mix design

- Sufficient workability so that there is no segregation
- Under load Enough strength to survive heavy wheel loads & tyre pressures.
- Sufficient durability
- Should be economical

Materials and Method

In order to study the effect of pvc waste in bituminous pavement as replacement of aggregate on stability of pavement 18 cube three for 0%,1%,2%,3%,4% and 5% each are prepared by cylindrical mould and hammer.

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Fig.3.1 Sample for Marshal Stability Test

Table: 3 Specification of Mould and Hammer

APPARATUS	VALUE	WORKING TOLERANCE
MOULD		
Average internal diameter, mm	101.2	± 0.5
HAMMER		
Mass, kg	4.535	± 0.02
Drop Height, mm	457	± 1.0
Foot diameter, mm	98.5	± 0.5

Basic material used for construction of pavement in these experiments

1. Aggregate
2. Bituminous binder
3. Filler material
4. Plastic

Type of aggregate

1. Coarse aggregate
2. Fine aggregate

Aggregate should have following properties

.

1. los angles abrasion test value shall not be more than 25%(ASTMCI 31)
2. weight loss in magnesium sulphte soundness test shall not be more than 18% (aasthot 104)
3. Flakiness index shall not be more than 25%(ms 30)
4. Water absorption should not be more than 2% (ms30)
5. The polished stone value should not be less than 40%

Fine aggregate

Fine aggregate should be clean screened it should be free from clay, loam, vegetation or organic matter. Properties of fine aggregate

1. angularity should not be less than 45%
2. methylene blue shall not be more than 10mg/l (onio department of transportation standard test method)
3. the weighted average weight loss in magnesium sulphate soundness test shall not be more than 20%
4. water absorption not be more than 2%(MS 30)

II. BITUMEN

Bitumen is hydrocarbon material of either natural or pyrogeneous origin found in gaseous , liquid ,semisolid or solid form and completely .bituminous material are very commonly used in highway construction because of their binding and their water proofing properties when bitumen contains some inert material or materials ,it is sometime called asphalt.

Crude petroleum obtained from different places is quite different in their composition. The potion of bituminous material present in the petroleum may widely differ depending on the source. Almost all the crude petroleum contain considerable amount of water along with crude oil. Hence the petroleum should be dehydrated first before carrying out the distillation Asphalt binder 60/70 and 80/100 are used in this research. Bitumen used have following properties.

1. Grade of bitumen used in the pavements should be selected on the basis of climatic conditions and their performance in past.
2. It is recommended that the bitumen should be accepted on certification by the supplier (along with the testing results) and the State project, verification samples. The procedures for acceptance should provide information, on the physical properties of the bitumen in timely manner.
3. The physical properties of bitumen used which are very important for pavements are shown below. Each State should obtain this information (by central laboratory or supplier tests) and should have specification requirements for each property except specific gravity.

(a) Penetration at 77° F
(b) Viscosity at 140° F
(c) Viscosity at 275° F
(d) Ductility/Temperature
(e) Specific Gravity
(f) Solubility
(g) Thin Film Oven (TFO)/Rolling TFO; Loss on Heating
(h) Residue Ductility
(I) Residue Viscosity

3. 1. ROAD TAR

The bituminous material is obtained by the destructive distillation of organic matters such as wood, coal, shale etc. in the process of destructive distillation the carbonation result in produce of crude tar which further refined.

3.2. CUT-BACK BITUMEN

The asphaltic bitumen is very often mix ed with comparatively volatile solvent to improve the workability of the material. The solvent get evaporated leaving behind the particles together. This cutback bitumen is classified into slow, medium and rapid curing depending upon the type of solvent used.

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3.3. EMULSION

Emulsion is liquid product in which a substantial amount of bitumen is suspended in finely divided condition in an aqueous medium and stabilizes by means of one or more suitable material. An emulsion is a two phase system. An emulsion is mixture of two immiscible liquid. Asphalt gets broken up into minute part in water in presence of emulsifier. It improves workability of bitumen or asphalt.

3.4. MINERAL FILLER

Mineral filler consist of fine inert mineral matter that is added to the hot mix asphalt to increase the density and enhance strength of mixture .these filler should pass through 7675μm IS sieve .filler may be cement or fly ash.

3.5. PLASTIC MATERIAL

Plastics are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, poly addition, and cross-linking.
There are two types of plastics:

1. Thermoplastic
2. Thermosetting plastic
3. Thermoplastic

Thermoplastic are those which don’t go under any chemical reaction when heated again and again can be moulded again and again. Examples include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene.
Thermosetting plastic
Thermosetting plastic are those which once molded doesn’t used again.

3.6. Types of Plastics

- PET, polyethylene terephthalate
- HDPE, high-density polyethylene
- PVC, polyvinyl chloride
- LDPE, low-density polyethylene
- PP, polypropylene
- PS, polystyrene

III. WASTE PLASTICS CONCERN

Plastics are durable & non-biodegradable; the chemical bonds make plastic very durable & resistant to normal natural processes of degradation. Since 1950s, around 1 billion tons of plastic have been discarded, and they may persist for hundreds or even, thousands of years. The plastic gets mixed with water, doesn’t disintegrate, and takes the form of small pallets which causes the death of fishes and many other aquatic animals who mistake them as food materials.
Today the availability of the plastic wastes is enormous, as the plastic materials have become the part and parcel, of our daily life. Either they get mixed with the Municipal Solid Waste or thrown over a land area. If they are not recycled, their present disposal may be by land filling or it may be by incineration. Both the processes have significant impacts on the environment. If they are incinerated, they pollute the air and if they are dumped into some place, they cause soil & water pollution. Under these circumstances, an alternate use for these plastic wastes is required.

Classification of Plastic Waste:

a) Polyethylene:

- LDPE (Low Density Poly-Ethylene):

Low density poly-ethylene this plastic waste available in the form of carry bags generally in stores these plastic bags are very thin and also easily available.

- HDPE (High Density Poly-Ethylene):

Generally High density poly-ethylene type of plastic waste is available in the form of carry bags and easily available in the market.

b) Polypropylene:

This plastic may be available in the form of carry bags or solid plastic it’s depend upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

Determination of specific gravity of polythene

The procedure adopted is given below

1) The weight of the polythene in air was measured by a balance. Let it be denoted by “a”.
2) An immersion vessel full of water was kept below the balance.
3) A piece of iron wire was attached to the balance such that it is suspended about 25 mm above the vessel support.
4) The polythene was then tied with a sink by the iron wire and allowed to submerge in the vessel and the weight was measured. Let it be denoted as “b”.
5) Then polythene was removed and the weight of the wire and the sink was measured by submerging them inside water. Let it be denoted as “w”.

The specific gravity is given by

$$\mathbf{s = a / (a + w - b)}$$

where:
a = apparent mass of sample, without wire or sinker, in air
b = apparent mass of sample and of sinker completely immersed and of the wire partially immersed in liquid
w = apparent mass of totally immersed sinker and of partially immersed wire.
From the experiment, it was found that
a = 19 gm b = 24 gm w = 26 gm
=> s = 19 / (19+26-24) = 19/21 =0.90476 Take s = 0.905

Sample Preparation

Mixing Procedure

The mixing of ingredients was done as per the following procedure (STP 204-8).

1) Required quantities of coarse aggregate, fine aggregate & mineral fillers were taken in an iron pan.
2) This was kept in an oven at temperature 160^0C for 2 hours. This is because the aggregate and bitumen are to be mixed in heated state so preheating is required.
3) The bitumen was also heated up to its melting point prior to the mixing.
4) The required amount of shredded polythene was weighed and kept in a separate container.

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5) The aggregates in the pan were heated on a controlled gas stove for a few minutes maintaining the above temperature.
6) The polythene was added to the aggregate and was mixed for 2 minutes.
7) Now bitumen (60 gm), i.e. 5% was added to this mix and the whole mix was stirred uniformly and homogenously. This was continued for 15-20 minutes till they were properly mixed which was evident from the uniform colour throughout the mix.
8) Then the mix was transferred to a casting mould.
9) This mix was then compacted by the Marshall Hammer. The specification of this hammer, the height of release etc. are given in Table – 4.1.
10) 75 no. Of blows were given per each side of the sample so subtotal of 150 no. of blows was given per sample.
11) Then these samples with moulds were kept separately and marked

Calculations involved

Total weight of sample = 1200 gm
Optimum Bitumen Content = 5 %
So weight of bitumen = 60 gm
Weight of aggregate + polythene = total weight of mix - 5% bitumen of mix=1200-60 =11

The polythene content was varied from 1 to 5 % and for each polythene content, 3 samples were prepared. The samples were named, the weight of polythene & aggregate for each sample were calculated and shown in Table – 4.2 below.

Table 5: Amounts of raw materials

polythene %	wt of polythene	wt of aggregate
	gm	Gm
0	0	1140
0	0	1140
0	0	1140
1	11.4	1128.6
1	11.4	1128.6
1	11.4	1128.6
2	22.8	1117.2
2	22.8	1117.2
2	22.8	1117.2
3	34.2	1105.8
3	34.2	1105.8
3	34.2	1105.8
4	45.6	1094.4
4	45.6	1094.4
4	45.6	1094.4
5	57	1083
5	57	1083
5	57	1083

Void analysis

For analysis of voids, the samples were weighed in air and also in water so that water replaces the air present in the voids. But by this process some amount of water will be absorbed by the aggregates which give erroneous results. Hence 1st the samples were coated with hot paraffin so that it seals the aggregate-bitumen mix completely and checks the absorption of water into it.

Mix Volumetric

The volumetric parameters (refer Figure 4.5) are to be checked from the Marshall samples, prior to Marshall test. The following are equations which would be used to determine volumetric parameters such as VMA, VA, VFB etc. and absorbed bitumen content (P_{ab}). The absorbed bitumen is a important parameter, which is ignored in bituminous mix design in many cases (Chakroborty & Das, 2005)

$$VMA = \left(1 - \frac{Gmb}{Gsb} \times Ps\right) \quad \text{.........} \quad (1)$$

$$VA = \left(1 - \frac{G_{mb}}{G_{mm}}\right) \quad \text{.........} \quad (2)$$

$$VFB = \left(\frac{VMA - VA}{VMA}\right) \quad \text{.........} \quad (3)$$

$$P_{ba} = 100\left[\frac{1}{Gsb} - \frac{1}{Gse}\right] \times Gb \quad \text{.........} \quad (4)$$

Where,

P_{ba} = Absorbed bitumen content as a percentage by weight of aggregates

G_{mb} = Bulk specific gravity of the mix

G_{mm}= Maximum theoretical specific gravity of the mix

G_{sb} = Bulk specific gravity of aggregates

G_{se} = Effective specific gravity of aggregates

G_b = Specific gravity of bitumen

VMA = Voids in Mineral Aggregates

VA = Air Voids

VFB = Voids filled with Bitumen.

G_{sb} = M_{agg} / volume of (aggregate mass + air void in aggregate + absorbed bitumen) - -(5)

G_{se} = M_{agg} / volume of (aggregate mass + air void in aggregate) - - -(6)

G_a = M_{agg} / volume of aggregate mass - - -(7)

G_{mm} = M_{mix} / volume of mix air voids - - -(8)

G_a = M_{mix} / bulk volume of the mix - - -(9)

G_{se} = (M_{mix} - M_b) / [(M_{mix} / G_{mm}) – (M_b/ G_b) - - -(10)

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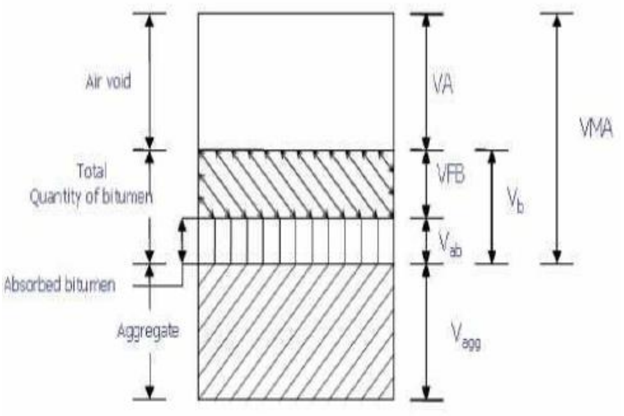

Phase Diagram for Mix Volumetrics

(Chakroborty & Das, Principles of Transportation Engineering)

To calculate value of G_{mb} we need to calculate the bulk volume of the sample for which

3 readings are needed. i.e.

- Weight of sample in air
- Weight of paraffin coated sample in air
- Weight of paraffin coated sample in water

All the parameters are shown in Table – 4.3, 4.4 & 4.5

Table – 6: Calculation of G_{sb}

polythene %	% of CA	% of FA	% of filler	% of pol	G_{sb}	G_{mm}
0	47.5	42.75	4.75	0	2.624745	2.43333
0	47.5	42.75	4.75	0	2.624745	2.43333
0	47.5	42.75	4.75	0	2.624745	2.43333
1	47.025	42.3225	4.7025	0.95	2.61319	2.393276
1	47.025	42.3225	4.7025	0.95	2.61319	2.393276
1	47.025	42.3225	4.7025	0.95	2.61319	2.393276
2	46.55	41.895	4.655	1.9	2.601737	2.354519
2	46.55	41.895	4.655	1.9	2.601737	2.354519
2	46.55	41.895	4.655	1.9	2.601737	2.354519
3	46.075	41.4675	4.6075	2.85	2.590384	2.316998
3	46.075	41.4675	4.6075	2.85	2.590384	2.316998
3	46.075	41.4675	4.6075	2.85	2.590384	2.316998
4	45.6	41.04	4.56	3.8	2.579129	2.280653
4	45.6	41.04	4.56	3.8	2.579129	2.280653
4	45.6	41.04	4.56	3.8	2.579129	2.280653
5	45.125	40.6125	4.5125	4.75	2.567971	2.245431
5	45.125	40.6125	4.5125	4.75	2.567971	2.245431
5	45.125	40.6125	4.5125	4.75	2.567971	2.245431

Table – 7: Calculation of G mb & bulk volume

Sample no.	Polythene %	wt of sample in air(W)	Wt of paraffin coated sample in air(W_1)	Wt of paraffin coated sample in water(W_2)	Bulk volume	G_{mb}
		Gm	gm	gm	cc	
1'	0	1196	1215	675	518.88889	2.304925
2'	0	1196	1214	678	516	2.317829
3'	0	1197	1215	679	516	2.319767
1	1	1202	1220	676	524	2.293893
2	1	1194	1213	674	517.88889	2.305514
3	1	1193	1212	674	516.88889	2.30804
4	2	1194	1224	666	524.66667	2.275731
5	2	1197	1224	667	527	2.271347
6	2	1192	1223	671	517.55556	2.303134
7	3	1206	1224	670	534	2.258427
8	3	1196	1222	661	532.11111	2.247651
9	3	1195	1225	660	531.66667	2.247649
10	4	1203	1221	659	542	2.219557

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11	4	1205	1223	662	541	2.227357
12	4	1212	1230	661	549	2.20765
13	5	1209	1228	655	551.88889	2.190658
14	5	1210	1229	657	550.88889	2.19645
15	5	1208	1230	652	553.55556	2.182256

Table – 8: Calculation of VMA, VA, VFB

Sample no.	polythene %	VMA	VA	VFB
1'	0	16.57556291	5.276911	68.16452
2'	0	16.10850103	4.746592	70.53362
3'	0	16.03835764	4.666949	70.90133
1	1	15.39714962	4.152575	73.03023
2	1	14.96855727	3.667019	75.50186
3	1	14.87540443	3.561485	76.05789
4	2	14.50180437	3.346262	76.9252
5	2	14.6664858	3.532431	75.91495
6	2	13.47225683	2.182382	83.80091
7	3	13.59858552	2.527865	81.41082
8	3	14.01085046	2.992954	78.63831
9	3	14.01092559	2.993039	78.63782
10	4	13.55906408	2.678882	80.24287
11	4	13.25530957	2.336894	82.37013
12	4	14.02278068	3.200966	77.1731
13	5	13.17783405	2.439313	81.48927
14	5	12.94828672	2.181374	83.15318
15	5	13.5108386	2.813505	79.17594

3.14 Marshall testing

The Marshall test was done as procedure outlined in ASTM D6927 – 06 . Marshall

Stability Value:

It is defined as the maximum load at which the specimen fails under the application of the vertical load. It is the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute (2 inches/minute). Generally, the load was increased until it reached the maximum & then when the load just began to reduce, the loading was stopped and the maximum load was recorded by the proving ring.

Marshall Flow Value:

It is defined as the deformation taken place by the sample at the maximum load where it fails or failure occurs. During the loading, an attached dial gauge measures the specimen's plastic flow as a result of the loading. The recorded flow value was 0.25 mm (0.01 inch) increments at the same time when the maximum load was recorded.

Two readings were taken from the dial gauge i.e.

1. Initial reading (I)
2. Final reading (F)

The Marshall Flow Value (f) is given by

$$\boxed{f = F - I}$$

The Marshall Stability Values and The Marshall Flow Values are are shown in Tables below

Table – 9: MARSHALL STABILITY VALUE (S)

Sample no.	polythene %	No. of divisions (N)	Marshall Stability Value (S)
			kN
1'	0	460	13.66
2'	0	500	14.85
3'	0	490	14.56
1	1	490	14.56
2	1	470	13.96
3	1	480	14.26
4	2	490	14.56
5	2	480	14.26

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6	2	500	14.85
7	3	520	15.44
8	3	530	15.74
9	3	520	15.44
10	4	570	16.93
11	4	600	17.82
12	4	620	18.41
13	5	540	16.04
14	5	520	15.44
15	5	550	16.34

Table – 10: MARSHALL FLOW VALUE

Sample no.	polythene %	Initial Reading (I)	Final Reading (F)	Marshall Flow Value (F)
				mm
1'	0	3.1	7.3	4.2
2'	0	3.3	7.4	4.1
3'	0	3.3	7.4	4.1
1	1	3.5	7.0	3.5
2	1	3.2	7.9	3.7
3	1	4.1	7.3	3.2
4	2	3.9	7.0	3.1
5	2	3.7	6.7	3
6	2	3.2	6.3	3.1
7	3	3.9	7.1	3.2
8	3	3.0	5.8	2.8
9	3	3.1	6.0	2.9
10	4	2.8	5.3	2.5
11	4	2.6	5.5	3.3
12	4	3.3	6.1	2.8
13	5	2.9	5.5	2.6
14	5	3.2	5.9	2.7
15	5	3.3	6.2	2.9

IV. ANALYSIS OF RESULTS

4.1 Plotting Curves

5 curves were plotted. i.e.

i. Marshall Stability Value vs. Polythene Content

ii. Marshall Flow Value vs. Polythene Content

iii. VMA vs. Polythene Content

iv. VA vs. Polythene Content

v. VFB vs. Polythene Content

vi. Bulk unit weight vs. Polythene Content

For each % of polythene, 3 samples have been tested. So the average values of the 3 were taken. The mean values are shown in Table.

Table – 11: Data for plotting curves

Polythene Content (%)	Unit weight (G_{mb})	Mean VMA (%)	Mean VA (%)	Mean VFB (%)	Mean S (kN)	Mean F (mm)
0	2.668241	16.24080719	4.896817	69.86649	14.35667	2.314174
1	2.628602	15.08037044	3.793693	74.86333	14.26	2.302482
2	2.584494	14.21351566	3.020358	78.88036	14.55667	2.283404
3	2.56012	13.87345386	2.837953	79.56232	15.54	2.251242
4	2.52277	13.61238478	2.738914	79.9287	17.72	2.218188
5	2.457956	13.21231979	2.478064	81.2728	15.94	2.189788

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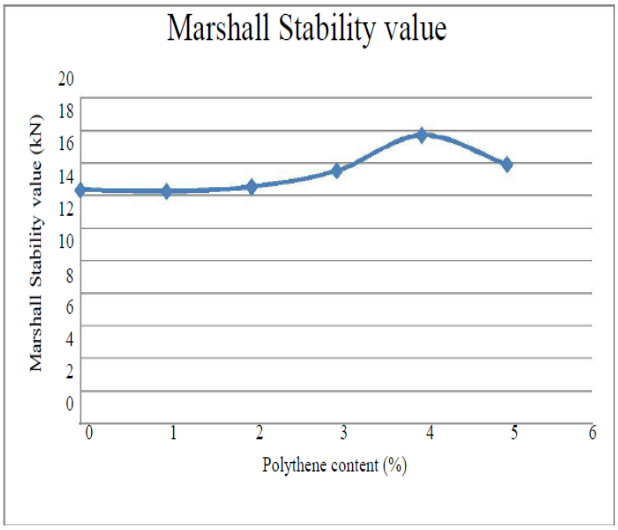

Figure – 4.1: Marshall Stability Value vs. Polythe ne Content

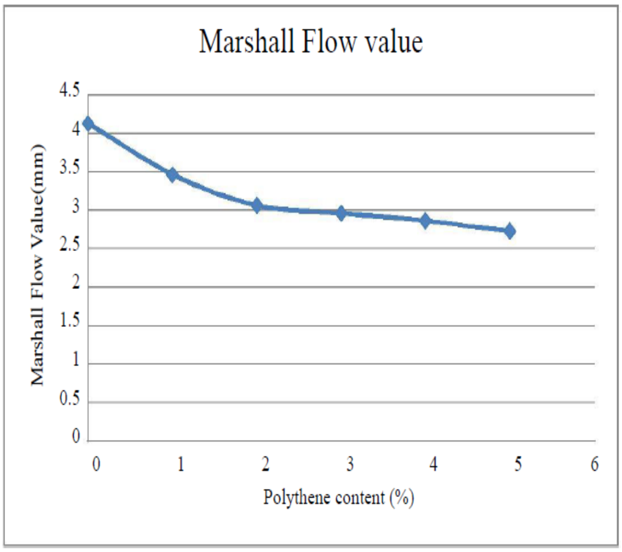

Figure – 4.2: Marshall Flow Value vs. Polythene Co ntent

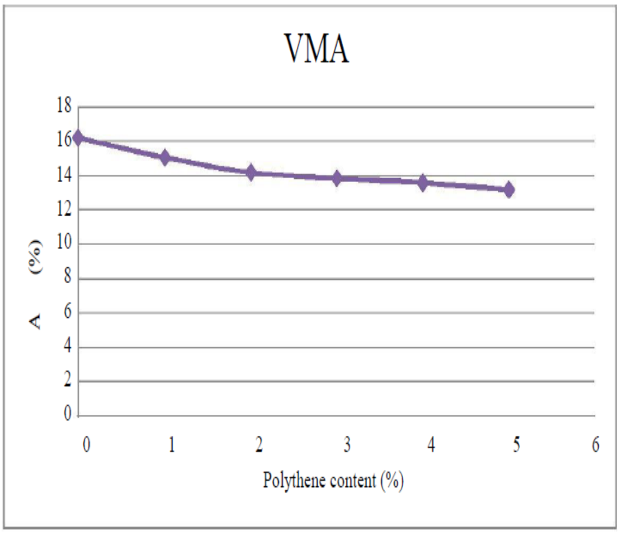

Figure – 4.3: VMA vs. Polythene Content

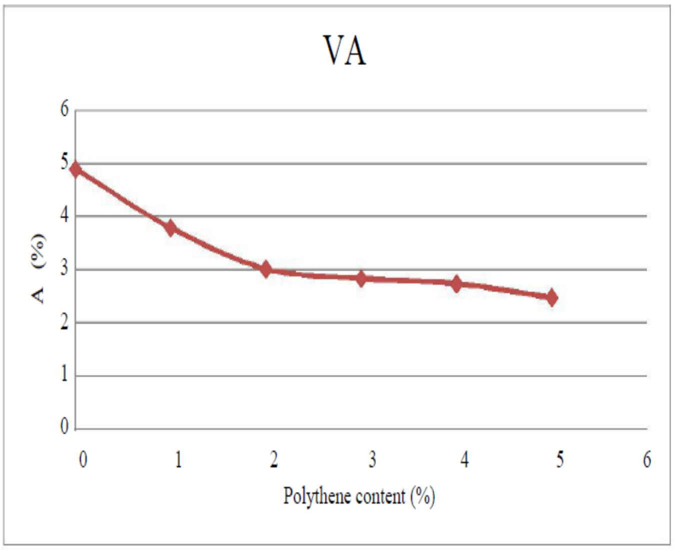

Figure – 4.4: VA vs. Polythene Content

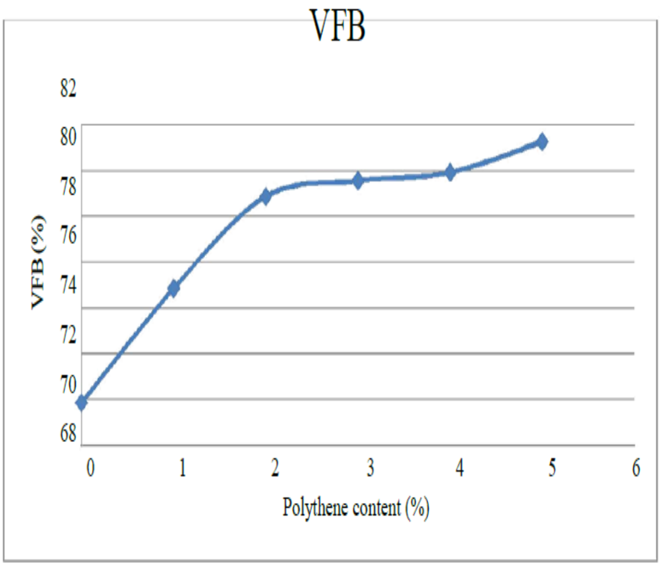

Figure – 4.5: VFB vs. Polythene Content

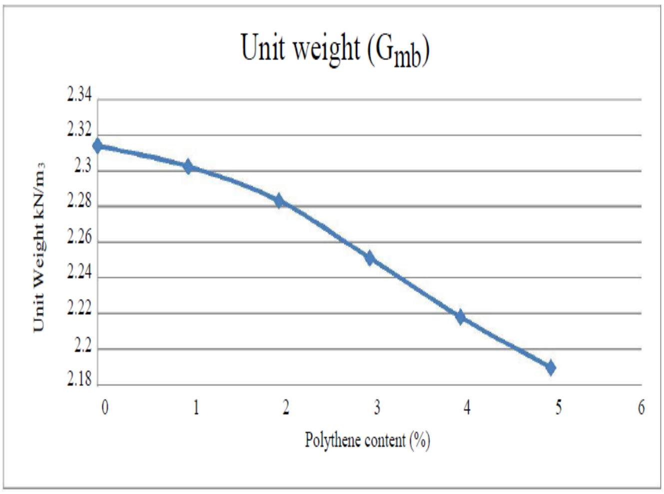

Figure – 4.6: Bulk unit weight vs. Polythene Content

4.2 Analysis

Finding Optimum Polythene Content

The value of polythene content at which the sample has maximum Marshall Stability Value and minimum Marshall Flow Value is called as Optimum Polythene Content.

From the Figure – 4.1 & 4.2 we get the Optimum Polythene Content as 4%. Also from Figures – 4.3, 4.4 & 4.5 we conclude that upon addition of polythene t he voids present in the mix decreases.

V. CONCLUSIONS

The study of polythene modified BC indicated that modified mix posses improves Marshall characteristic in general. The observation are:

a. It is observed that the stability value increase up to 4% of polythene content then decrease
b. It is observed that Marshall flow value decreases upon addition of polythene i.e resistance to deformation ,VMA,VA,VFB increases to load applied
c. Polymers modified pavement is a boon to India's hot and humid climate. Where temperature rise is above 50°C nearly, rains create havoc leaving roads distressed. Where effect adversely to life of pavement .The use of modified BC increases surface area of contact to interface which ensures better bonding between aggregate and bitumen and reduces void space. This results in to lesser moisture absorption and oxidation of bitumen, a more stable and durable pavement.
d. The investigation not only uses waste plastic but also provide improved pavement with better strength and longer life span. The study will have a positive impact on the environment as it will reduce the volume of plastic waste to be disposed off by incineration and land filling. It will not only add value to plastic waste but will develop a technology, which is eco-friendly.

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