USE OF WASTE PLOYETHYLENE IN BITUMINOUS CONCRETE

Tanveer Ali Dar[1], Er. Bharmjeet Singh[2]
[1]Master of Technology in Transportation Engineering (Regular)
[2]Assistant Professor, Department Of Civil Engineering, Desh Bhagat University, Mandi Gobindgarh, Punjab.

Abstract: Bituminous Concrete (BC) a composite material that is mostly used in constructionprojects like road surfacing, airports, parking lots etc. It consists of asphalt orbitumen (used as a binder) and mineral aggregate which are mixed together & laid downin layers then compacted Now a days, the steady increment in high traffic intensity in terms of commercialvehicles, and the significant variation in daily and seasonal temperature put us in ademanding situation to think of some alternatives for the improvisation of the pavementcharacteristics and quality by applying some necessary modifications which shall satisfy both the strength as well as economical aspectsAlso considering the environmental approach, due to overuse of polythenesin day to day business, pollution to the environment is enormous. As polythenes are not biodegradable, the need of the current hour is to use the wastepolythene in some beneficial purposes. This paper also presents a research work on the behavior of BC mix modifiedwith waste polythene.The different quantities of polythene are used for preparation of these mixes with anappropriateaggregate grading as given in the IRC Code. The properties of polythene in the mix is studiedfor different engineering properties by preparing the Marshall samples of BC mixtures withand without polymer.
Keywords: Bituminous Concrete (BC), Stone mix asphalt(SMA), Dense Bound Macadam(DBM), Khyber Polyethylene, Marshal Values.

I. INTRODUCTION

Bituminous concrete mixes are widely used in the pavement industry. The pavement has different sections. The main components of the bituminous (BC) concrete are combined with the bitumen. Usually, all kinds of pavements are divided into two categories, flexible and rigid.
Flexible pavement: If the road surface constitutes bitumen, it is called flexible because the general road structure can get bent due to the vehicular loads.
Rigid pavement: If the PCC is used for the surface of roads, it is reffered as rigid one because the general surface of the pavement cannot get bent or distorted due to car loads. These modes of surfacing are far more complex than the flexible ones. The modified thing we can do for the flexible type of roads is that we can reinforce it with the steel to reduce or eliminate joints.

II. REVIEW OF LITERATURE

During the mid-1900's, bitumen began to be used on street roads, on rural roads to prevent the rapid removal of particles such as dust from the Water Bound Macadam , caused by rapid growth of vehicles [Roberts] and others. 2002]. in the first phase, heavy oils were used to prevent dust removal. The visual test, called the pat Test, is used to measure the required amount of heavy oils in the mix. The first integrated design method for mixing was the Habard field method, which actually begins with a mixture of bitumen and sand. Many mixtures with large particles cannot be treated this way. This was one of the drawbacks of this process. Francis, 1942; who was the project engineer of the California Highway Administration, developed Hveemstabilometer, hehadno previous collaborative experience, the required , so he decided to measure different boundaries to mix to obtain the bitumen value [Vallerga and Lovering 1985]. The surface area calculation concept, (already used, during concrete design) is a mixture of concrete, which is used to measure the bitumen value that is really needed. Bruce Marshall developed a Marshall Test machine before World War II, used by the US Army Corpes of engineers in 1930 and later modified in 1940 and 50’s. Bahia and Anderson, 1984; worked on visco-elastic nature of bindersand stability and found that complex compounds and phase angle of binders should be measured with different loading and climatic conditions. Shukla and Jane (1984) explained that the wax effect of bitumen can be reduced by adding EVA (Ethyl Vinyl Acetate), fragrant resin and SBS in wax bitumen. An addition of 4% EVA or 6% of SBS or 8% resin at wax bitumen reduces the melting of pavement at higher temperatures, segregation at high levels of heat and frost action at low heat levels. The results of studies made by the Shell Research and Technology Canter in Amsterdam indicate that the segregation rate is significantly reduced due to mixing of binder with SBS. Button (1998), based on controlling stress depression at 20 and 0C, and concluded that polymeric SBS showed higher features of fatigue resistant properties than AC-5.
Schuler et al. (1987) found that the resistance against tention of changed SBS mix increased significantly compared with non-alteration mixtures of asphalt at 21, 25 and 41 ° C.Collins et al. (1991) and Baker Baker (1998) noted that changed SBS asphalt mixtures have longer life than non-asphalt mixtures. The addition of SBS polymer to mix of bitumen increases its resistance and breakdown at low temperatures. Dunning and Cars well (1981) reported that asphalt concrete using integrated synthetic polyethylene compounds could have contributed to continuous development in high temperatures. Gudrich (1998) reported that fatigue and mixing polymer modified properties increased significantly compared to non-asphalt integration.
Indian road congress indication 53 (2002) indicate that the

next renewal period can be increased by 50 percent if the bitumen is modified as against free bitumen. Aggregate is a granular fraction of bituminous concrete mixtures that make up 90-95% of the weight of the combine and also contribute bearing load property of the pavement. Therefore, all components should be controlled to ensure the efficiency.Desirable aggregate properties that should be used on the pavement are described below

1) The aggregates should have small plasticity. The availability of clay content with bituminous mixtures can lead to problems such as inflammation and adhesion of the bitumen on the rock that can cause problems to eliminate. Small clay particles that cannot mix with mix should be limited to 1%.
2) Resistance against wear and tear and climate change should be measured by utilization of the sulphate soundness method.
3) The amount of dust to asphalt content, according to weight should be a maximum of 1.2 & minimum 0.6.
4) It is recommended that AASHTO T-209 be used to determine the maximum maturity of bituminous concrete mixtures.

Aggregates have two types. i.e.
a) Coarse Aggregates (CA)
b)Fine Aggregates (FA)

a) Coarse Component (CA)
The amount retained on 4.75 mm on ISSieve are coarse type. These aggregates should bescreened, angular shape, without particles of dust, mud, plant and living matter. They should have following properties:
1) The Los Angeles Abrasion value might not exceed 25% (ASTM C131).
2) The weight loss measured by the magnesium sulphate test rate should not exceed 18% (NO T 104).
3) The flakiness index might not exceed 25% (MS 30).
4) Water access might not exceed 2% (MS30)
5) The polished aggregate value of stones should not be less than 40%.

Fine aggregates (FA)
These types should be pure dust. They should be free of clay, hay, plants or living things. The FA must have the following locations
1) The angularity might not be less than 45% (ASTM C 1252).
2) Blue methylene might not exceed 10 mg / g (Department of Transportation Ohio).
3) The weight loss limit for the magnesium sulphate test rate might not exceed 20% (AASTHO T 104).
4) Water which gets absorbed by aggregates, should not exceed 2% (MS30)

Bitumen
Asphalt with 60/70 and 80/100 values have been applied in this investigation. Bitumen should have the following properties.
a) Bitumen grade usedshould be chosen in terms of their weather type and performance in the past.
b) It is recommended that the bitumen should be accepted by the supplier's certificate (and test results) and verification of samples by government project. Acceptance procedures should provide information, bitumen body parts in a timely manner.

Polythene
The polyethylene used for KHYBER milk containers was used as a raw material for samples. These polyethylene structures were collected, washed and was filtered by placing it in hot water for 3-4 hours. Then dried up
Specific Gravity of polythene = 0.905
Heat:Dried polyethylene packages are divided into two small pieces. This is because if you include polyethylene and bitumen and aggregate, make sure the mixture is suitable. Fragments of polyethylene are very likely to mix with bitumen.

Fig.1: KHYBER Polythene used

Fig2: SHREDDED POLYTHENE

III. EXPERIMENTAL WORK

Determination of gravitational specific gravity
The following procedure is used
1) Measure the weight of Polythene in the air by balance. It is represented by “a”
2) Water-filled container contained in equality.
3) Connect the balance to the wire approximately 25 mm above the container's support.
4) Then polyethylene sink with a wire and sink it in the container and measure weight. It is represented as "b".
5) Then remove the polyethylene and measure the weight of the wire and sink it under water. It isrepresented as "w". ...

Required specific gravity of sample(s) is then gven by:
$s = a / (a + w-b)$
Observations:
a = 19 gm
b =24 gm
w = 26 gm
putting the values in it

s = 19 / (19+26-24) = 19/21 =0.904760
Take s = 0.905.

Sample Preparation
Marshall Sampling Mould
The specifications of the Marshall sampling mould and hammer are given in table 1

Table - 1: Dimensions of Marshall Sampling mould & 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


Fig. 3 marshall sampling mould


Fig. 4: Marshall Hammer

Mixing Procedure
Mixtures of ingredients are performed as the following procedure (STP 204-8).
1) Most bulk coal, aggregate and mineral fillers are taken in iron pan.
2) This is stored in the oven at 160 C heat for two hours. This is because the aggregate and bitumen should be mixed into the heat system for use in process.
3) Bitumen is also heated until point of melting of mix is reached.
4) The required amount of shredded polythene was measured and stored in one container.
5) The aggregates on the pan were warmed in a controlled gas cell for a few minutes that kept the heat above.
6) Polythene was added to aggregate and was combined for two minutes.
7) Bitumen (60 gm.) , 5% was added to this mixture and all the mixture was stimulated simultaneously . This was held for 15-20 minutes until the perfect match fit in all the mixing.
8) Then mixing was transferred to the mould.
9) This consolidation was then in line with Marshall Hammer. The description of the hammer, the height of the release etc. is provided in Table -1.
10) 75 no. of blows given to each sample and therefore a minimum of 150 no. were given to each sample.
11) These mould. samples were then kept separate and marked


Fig. 5: Marshall samples


Fig. 6: closer view of a Marshall sample

Calculations involved
Total weight of the sample = 1200 gm.
Optimum Bitumen Content = 5 %
So weight of bitumen = 60 gm.
Weight of aggregate and polythene = 1200-60 =1140 gm.
The polythene content was varied from 1 to 5 % and for each polythene content, 3 samples were prepared.
The samples are named and the weight of polythene and aggregate for each sample are calculated and shown in Table - 2 below.

Table 2: Amounts of raw materials

polythene %	wt. of polythene Gm.	wt. of aggregate Gm.
0	0	1140
0	0	1140
0	0	1140
01	11.40	1128.60
01	11.40	1128.60
01	11.40	1128.60
02	22.80	1117.20
02	22.80	1117.20
02	22.80	1117.20
03	34.20	1105.80
03	34.20	1105.80
03	34.20	1105.80
04	45.60	1094.40
04	45.60	1094.40
04	45.60	1094.40
05	57	1083
05	57	1083
05	57	1083

ANALYSIS OF RESULTS
Plotting Curves
5 curve organizations.
I. Marshall Stability Value Comparison with Content Polyethylene
II. Marshall flow value and content polyethylene
III. VMA and polyethylene content
IV. VA and Polyethylene content
V. VFB and Content Polyethylene
VI. Mass weight with the polyethylene content

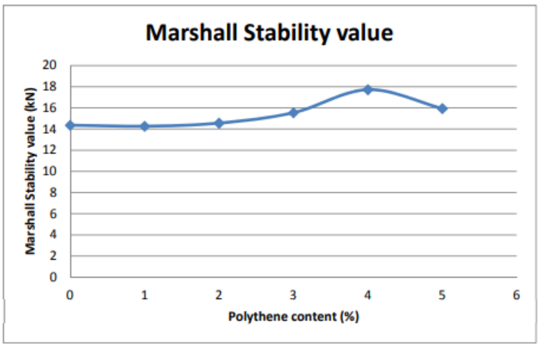

Fig 7: Marshall Stability Value vs. Polythene Content

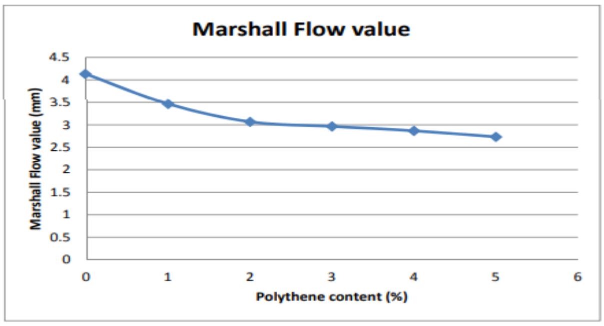

Fig 8: Marshall Flow Value vs. Polythene Content

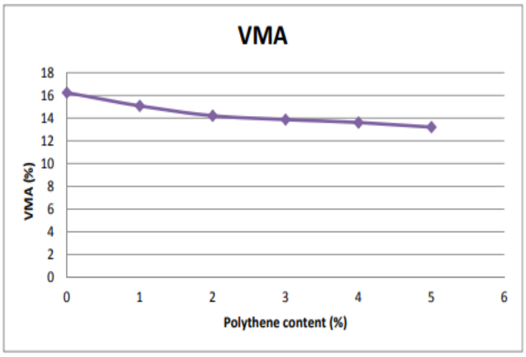

Fig 9: VMA vs. Polythene Content

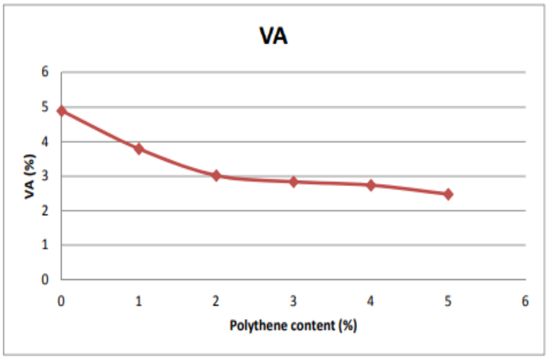

Fig 10: VA vs. Polythene Content

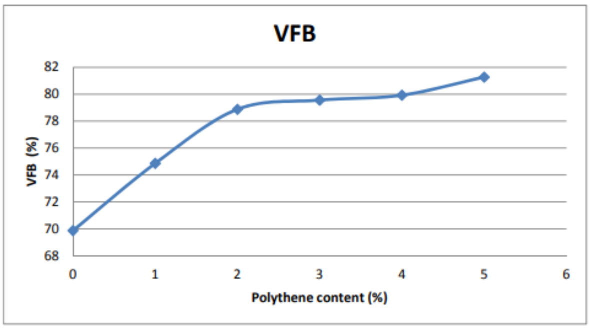

Fig 11: VFB vs. Polythene Content

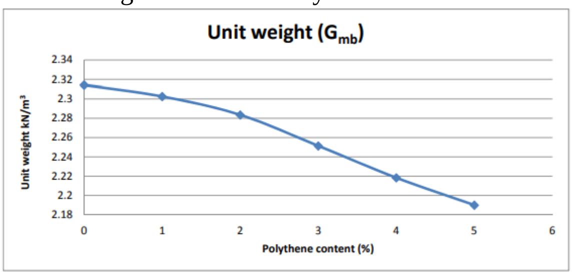

Fig 12: Bulk unit weight vs. Polythene Content

Analysis
Finding Optimum Polythene Content
The percentage of polyethylene content with the highest number of Marshall Stability value and minimum Marshall Flow value is the optimum percentage or content of polyethylene to be added to the mix. From Figure 7 and 8 we find the optimum content of polyethylene as 4%, and from 9, 10,11 and 12we conclude that upon addition of polyethylene voids in the mix gets decreased and at the optimum polyethylene content (4%) these values are within required specifications.

IV. CONCLUSIONS

From the study of the modified BC behaviour, it was found that the modified mixture had improved Marshall Properties. It was observed that the value of the Marshall stable value increase with the polyethylene content up to 4% and thereafter gets decreased. We observe that the value of the marshal flow decreases with the addition of polyethylene content, that is, it increases the resistance aganist distortions under heavy loads. The values of the parameters such as VMA, VA and VFB are within the required specifications at the optimum polythene percentage or content.

Given these factors, we can confirm that we can obtain a more stable and permanent pavement mixture through polymer modifications. This small modification not only utilizes beneficially non-biodegradable plastic waste materials, but also provides us with an improved pavement with greater strength and longer life.

REFERENCES

[1] Annual Book of ASTM Standards, 1999. ASTM D-6373, Standard Specification for Performance Graded Asphalt Binder, pp: 1102-1136.

[2] AslamShahan-ur-Rahman "Use of Waste Plastic in Construction of Flexible Pavement", New Building Materials & Construction World, 2009.

[3] Bahia, H.U. and Anderson, D.A., Strategic highway research program binder rheological parameters: Background and comparison with conventional properties. Transport. Res. Rec. 1488, 1995, 32-39.

[4] Vasudevan R., Nigam S.K., Velkennedy R., Ramalinga Chandra Sekar A., Sundarakannan B. Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers, International Conference on Sustainable Solid Waste Management, 5 - 7, Chennai, India pp-105-111, 2007.

[5] Baker, R.E., Polymer modified bitumen. Indian Highways, 1998, 1, 85–94.

[6] Button, J.W. and Little, D.N., Additives Have Potential to Improve Pavement Life, 1998 (Roads and Bridges: USA).

[7] Collins, J.H., Bouldin, M.G., Gelles, R. and Berker, A., Improved performance of paving asphalt by polymer modification. Proc. Assoc. Asphalt Paving Technol., 1991, 60.

[8] Das, A., (1998). Analytical design of bituminous pavements based on field performance, unpublished PhD thesis, Civil Engg. Dept., IIT, Kharagpur.

[9] Denning, J.H. and Carswell, J., Improvement in rolled asphalt surfacing by the addition of organic polymers, Report LR 989, TRRL, Crowthrone 1981.

[10] Justo C.E.G. and Veeraragavan A "Utilization of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads", Centre for Transportation Engineering, Bangalore University, Bangalore, India, 2002.

[11] Palit, S.K., Reddy, M.A., Reddy, K.S. and Pandey, B.B., Performance evaluation of crumb rubber modified bituminous mixes. Proceedings of National Seminar on Road Transportation in India: Emerging Trends and Techniques, 2002 September 12–13 (IIT Kharagpur: India).

