



An EXPERIMENTAL INVESTIGATION OF BITUMEN MIXES WITH LDPE FOR ROAD STABILITY

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ABSTRACT

With the rapid growth of economic activities along with the industries and population growth, it is to have the lives of road longer and requires less due to the commonly arisen problems of fatigue. It is desirable, expansion, and contraction due to temperature change and swelling of pavements due to access rainwater. In this present investigation I tried to use the plastic wastes in the surrounding environment. The marshal mix consists of bitumen blend along with the LDPE (Low density poly-ethylene) manufactured by dry process. The comparison had been made by controlling the bitumen and LDPE percentage in the marshal mix, various testing sample had been prepared. The laboratory test was performed in order to find the mix design characteristics on the various sample. The entire investigation is categories in the following three procedures.

1. Test had been performed to find Marshal and other physical properties on the sample consist of ordinary bitumen mix. i.e. DBM with varying percentage of 4.5 to 6% of the total weight.
2. In second stage of investigation the bitumen percent were kept constant that is 5.5 % of the overall weight of the mix and the LDPE percent were varying 2%, 4%, 6% and 8% of the weight of bitumen in order to find the the appropriate percentage of LDPE in the the Marshall mix design.
3. In the final stage of investigation the test sample had been prepared consists of constant percentage of LDPE (6%) and varying percentage of bitumen 4.5%, 5%, 5.5% & 6%.

After various tests perform on laboratory on the Marshall mix sample, the result obtained had been compared with one another in order to get the optimum percentage of LDPE and bitumen blend.

KEYWORDS: Bitumen, LDPE, Blending, Marshal, VMA, VFB

INTRODUCTION

Now it's been a serious concern for the government and society because of day by day increasing the volume of waste plastics. Our earth and ecosystem followed by animals and human beings are badly get affected due to the waste plastics, various researches had been made on the use of waste plastics in the construction of bituminous road pavement with their varying percentage in the marshal mix. Several researchers performed this study to work out the enhancement in properties. Aslam [1] developed a modified technique for the construction of flexible pavements. Plastic coated aggregate enhance binding properties within the construction of bituminous pavement.

Justo and Veeraragavan [2] Use of the plastic bags Hindi vitamins concrete mixers as an additive. In this study comparison has been made between normally used bitumen and LDPE mixed bitumen. Sheikna and SivaPrakash et al [3] conducted investigation on recycling plastic waste as a additive along with the bitumen to get roads. Sabina et al. [4], describes the comparative performance of properties of

bituminous concrete mixes containing plastic polymer with conventional bituminous concrete mixes.

The clear objective of the present research is to the study of physical properties of 60/70 grade bituminous mix (DBM) without using LDPE and the use of LDPE with the varying percentage of 2%, 4%, 6% & 8% by taking bitumen content of 5.5% in the marshal mixes along with 6% of LDPE and modified bitumen by keeping LDPE constant and varying bitumen binder of 4.5%, 5%, 5.5% & 6%. Various test were performed on the test sample are as following:- penetration test, Fire & flash point, softening point test, relative density & ductility test are evaluated within the present study by performing designated laboratory experiments. Marshal stability test has been performed on various samples for comparing the test result and found the suitable binder content and LDPE content on the mix design.

MATERIALS AND METHODS

The bituminous blend configuration expects to decide the extent of bitumen, filler, fine totals, and coarse totals to

create a blend that is useful, solid, strong, and efficient. The fundamental materials utilized are as per the following:

- Aggregates
- Cement
- Stone dust
- Bituminous Binder
- Low-density Poly Ethylene

Aggregates obtain from mines or glacial are used to produce a bituminous blend, which showed good properties against abrasion, crushing, and impact loadings also they having very good interlocking properties, which helps to construct the pavement strong & durable. But to enhance the durability of pavement and to make the aggregate more effective against the external load coming on the pavement it's found better to used additionally prepared aggregates by using industrial by-products like steel slag, fly fiery debris and so.

2.1. Coarse aggregates- The coarse aggregates can be classified based on IS sieve analysis, the aggregate particles which retain on 4.75 mm sieve is termed as coarse aggregate and the particle passing from 4.75 mm IS sieve is falling under the category of fine aggregate. In this investigation the aggregates of three different sizes were adopted that is 20mm, 10mm & 6mm. Selection of such three proportions improve the denseness of the pavement.

2.1.1 Fine aggregates-Fine aggregates can be classified as aggregate size passing from 4.75 mm IS sieve and retained on 0.75 mm IS sieve were termed as fine aggregate. It is work as a filler in the mix design and enhance the bulk density by lowering void ratio.

2.1.2 Filler-The particle passing from 0.075 mm IS sieve is termed as filler. Its function on the mix to fill the voids Present among the particles, which help in made the pavement dense and compacted. In this study use of stone dust and cement were used as a filler. Stone dust is a waste material obtained from the stone crushers. Stone dust and cement is used as a partial replacement of sand. In addition to this it also helps to conserve the natural sand resources. In the present study an experimental study was carried out to determine the Marshal properties using stone dust and cement as a filler.

2.1.3 Bituminous Binder-Bitumen acts as a binding material for all the constituent present in the mix. It has both viscous and elastic properties. In this study 60/70 bitumen grade was used as a binder, which showed significant properties.

2.1.4 LDPE-Low-density polyethylene (LDPE) is a thermoplastic made from the monomer ethylene having good properties against chemical attack. LDPE is widely used for the manufacturing of various containers, dispensing bottles, wash bottles, plastic parts for computer components, and widely used in plastic bags. It was the first grade of polyethylene produced by the imperial chemical industry (ICI) in 1933 using a high-pressure process via free radical polymerization. It is a homo-polymer, primarily used for packing of materials.

Free-radical polymerization (FRP) is a method of polymerization by which a polymer forms by the successive addition of building blocks of the molecules. Free radicals can be formed by several different mechanisms, usually

involving separate initiator molecules, Hence helps in the growing polymer chain.

Specifications of MORTH:-

Ministry of road transport and highway (MORTH) suggested specifications for all kinds of road works. The experimental results obtained are compared with MORTH specification for DBM. Specifications for DBM are as follows:-

TABLE-1) Requirement for Dense Bituminous mix:-

Stability(KN at 60°C)	9.0
Min flow value (mm)	2.0
Max flow value (mm)	4.0
Compaction (Number of blows)	75 blows, on each of the faces of the specimen.
% Air voids	3-6
% Voids in mineral aggregate(VMA)	As per specification(Table 4.2)
% Voids filled with bitumen (VFB)	65-75

Table-2) % Voids in mineral aggregate (VMA):-

Nominal Particle Size (mm)	Minimum VMA % Required for Design Air Voids		
	% Air Voids 3.0	4.0	5.0
9.5	14.0	15.0	16.0
12.5	13.0	14.0	15.0
19.0	12.0	13.0	14.0
25.0	11.0	12.0	13.0
37.5	10.0	11.0	12.0

RESULTS

3.1 Test Properties of Aggregates:- Various laboratory test were performed on coarse and fine aggregate of DBM. The result obtained is as follows:-

Table 3 - Test Properties of Aggregates

Property	Size of the Aggregate				
	20 mm	10 mm	6 mm	Stone dust	Cement
Specific gravity	2.74	2.63	2.61	2.58	3.06
Density (g/cm ³)	1.55	1.46	1.46	1.41	1.33

3.1.1 Test properties of 60/70 grade bitumen:

Various laboratory test were performed to find the test properties of ordinary bitumen mix design test samples, the result obtained is as follows:-

Table 4 - Test properties of 60/70 grade bitumen mix design sample

S.No.	Properties	Test Results
1.	Penetration value @ 25°C/100gm/5Sec,mm	68
2.	Softening point in °C	62
3.	Ductility in c.m.	99
4.	Specific gravity at 27°C	1.0023
5.	Flash point in °C	313
6.	Fire point in °C	341

3.1.2 Tests on Marshall Samples:-

Marshall test gives marshall stability value and related parameters when test sample is loaded. In the present research, i had taken the varying bitumen percent of 4.5 to 6% in the test sample, various sample had been prepared, in first phase testing of ordinary mixes using 60/70 grade bitumen is performed and then DBM with varying LDPE percent of 2%, 4%, 6%, 8% was tested and at last DBM with fix LDPE percent of 6% with varying percent of bitumen 4.5 to 6% is tested.

It had been found that mix containing 6% of LDPE showed the better marshall stability, it also reduce the bitumen percentage of 5.5% to 5%. The other important properties like bulk density, VMA, VBF, flow value & air voids was improved. With the increase in bitumen content the stability again starts to decrease. The maximum stability was achieved at 5% binder content along with the 6% of LDPE. This bitumen stability increases after a further increase in bitumen content at which stability is maximum is termed as optimum binder content. The rutting failure of the pavement

would be restrained to minimum amount which result in decrease of maintenance cost.

3.1.3 Results of ordinary bitumen 60/70 grade Mix Design for DBM:-

The Marshall stability test were conducted on the sample prepared using ordinary vitamin 6578 by wearing the the vitamin contain from 4.5% to 6%. The best properties of all the samples were evaluated and also graph were plotted to find the optimum value of binder content by which gate the pain vitamin value of 5.5 %. **Table-A** showing the various test values.

3.1.4 Results of DBM modified by varying LDPE & 5.5% binder content:-

The outcomes and investigation for normal bitumen blend shows that ideal fastener content for the blend is 5.5% of the total weight of mix design. By utilizing this ideal cover content for example 5.5% different examples of shifting LDPE rates (2%, 4%, 6%, and 8%) were readied and resulting test had been performed to discover properties of altered thick bitumen blend. **Table-B** shows different properties of LDPE altered DBM.

The outcomes show that expansion in level of LDPE in blend builds marshall soundness, mass thickness and a void loaded up with bitumen (VFB) yet diminishes air voids. It has been seen that altered blend shows better marshall dependability at 8% LDPE yet VFB surpasses the restricting worth, so the ideal portion of LDPE is chosen as 6%. Presently the test was performed to locate the ideal cover content with 6% LDPE altered blend.

3.1.5 Result of DBM with 6% LDPE modified bitumen and varying percentage of bitumen binder:

The outcome and investigation for DBM with 6% LDPE and varying percentage of bitumen 4%, 4.5%, 5%, 5.5% result in enhancement of marshall properties respectively shows excellent marshall properties. **The Table-C** shows the properties of DBM with 6% LDPE modified bitumen. The maximum value of marshall stability were found 1446 kg, when used 5% of bitumen as a binder. It's been also found during investigation that the flow value and bulk density increases and VMA% & VFB% are in the specified range, the amount of binder is reduced by 0.5% of the total binder content, investigation showed significant results on using 5% bitumen content in the marshall mix.

Table A-Results of ordinary bitumen 60/70 grade Mix Design for DBM:-

% bitumen	Weig ht of sampl e (gm)	Marsh al stabilit y (Kg)	Flow value (mm)	Bulk Densit y (gm/cc)	% Air Voids	% VMA	% VFB
4.5	1878	1160	2.41	2.345	5.38	14.29	62.37
5.0	1886	1235	2.55	2.373	4.79	15.05	68.19
5.5	1188	1263	2.67	2.387	3.81	15.14	73.84

6.0	1190	1233	2.83	2.348	3.34	15.25	78.11
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Table B- Results of DBM modified by varying LDPE & 5.5% binder content:-

% LDP E	Weight of sample (gm)	Marsh al stability (Kg)	Flow value (mm)	Bulk Densit y (gm/cc)	% Air Voids	% VMA	% VFB
2%	1885	1298	2.43	2.370	3.94	13.35	70.36
4%	1875	1346	2.54	2.379	3.82	14.57	73.65
6%	1872	1383	2.60	2.381	3.76	15.23	74.39
8%	1887	1410	2.73	2.368	3.72	16.02	76.25

Table C-Result of DBM with 6% LDPE modified bitumen and varying percentage of bitumen binder:

% bitu men	Weight of sample (gm)	Marsh al stability (Kg)	Flow value (mm)	Bulk Densit y (gm/c e)	% Air Voids	% VMA	% VFB
4	1885	1351	2.55	2.40	4.56	14.46	68.40
4.5	1880	1391	2.60	2.41	4.44	14.97	70.18
5	1884	1446	2.75	2.42	4.21	15.30	72.40
5.5	1888	1411	2.83	2.39	4.02	15.44	75.87

DISCUSSION

The use of DBM with the addition of LDPE increases to the melting point of the bitumen. By this investigation the result found were not only strengthen the bituminous pavement but also enhanced the serviceability & durability. Plastic roads would prove advantageous for India because of humid climate, where temperature commonly across 40-50°C and high Rainfall caused potholes, But due to enhancement of the properties of marshal mix by adding LDPE will prove excellent resistance against potholes. The aggregate is modified by coating with polymers showed excellent to enhance the property of flexible pavement & aggregates. The result parameter obtained from the investigation lead to

the economy and the problem-solving against fatigue and rutting, expansion and contraction of the pavement due to temperature change, Pat holes etc. and increases stability.

CONCLUSION

- 1) From test results it had been found that the flow value and the marshal stability value of the DBM sample increases on addition of LDPE.
- 2) The ordinary mix design of bitumen grade 60/70 showing the Marshall stability value of 1265 kg, although the DBM modified with LDPE were showing the Marshall stability value of 1448kg, hence it is clear that the addition of LDPE on DBM inhance the physical properties of the Marshall mix.
- 3) Use of LDPE-6%, in the Marshall mix lowers the optimum binder content by 0.5 % as compare by ordinary bitumen mix design.
- 4) The result obtained from DBM modified by LDPE provides the outcome as per the MORTH specification. The the values obtained are in the specified range which proved the acceptability of the bituminous mix modified by LDPE.

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