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Evaluation Of Bituminous Mix Parameters With Addition Of Plastic Waste

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ABSTRACT:Road construction is the main integral part of the developing countries. The conventional method has been proven perfect for the road construction but now, time has come where there is a need of enhancement of properties of bituminous mix with the help of other binder materials. The use of waste plastic is road pavements is the smartest solution for its reuse. In current study, conventional and modified bituminous mixes with different plastic percentage are prepared using Low Density Polyethylene (LDPE) at normal mixing and compaction temperatures. The Dense Bituminous Macadam (DBM) is selected as gradation for study. The VG-30 is used as binder and shredded waste plastic have been used as an additive. Addition of LDPE has enhanced the properties of bituminous mix such as stability, flow value, air voids and specific gravity. From obtained results it was noted that 4% (by weight of bitumen) plastic has increased the stability & flow value.
Keywords _- Waste Plastic, Marshall Test, Aggregate, Modified Bitumen, LDPE.

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I. INTRODUCTION:

Plastic is used everywhere in today's lifestyle and its disposal after use is a great problem. It is a non-biodegradable product due to which these materials pose environmental pollution. If a ban is put on the use of plastics in market, the real cost would be much higher. Both these issues when taken together lead to a single solution that we can use this waste plastic in flexible Pavements in such a manner that it gets coated over the surface of aggregate by heating (140˚C - 160˚C), because plastics like PE, PS, PP used in PET Bottles, disposal glasses, handbags, covers of various appliances etc. soften up to 160˚C. As the plastic melts at the bitumen heating temperatures no external resources are required for heating or melting the same plastic, therefore does not increase or hamper the production cost of bituminous mix. Research works on various types of Polymer Modified Bitumen (PMB) are available in literature. The feasibility of using waste plastic has also been examined by many researchers.

The experiments conducted in the laboratory depict fruitful results can substantially increase the stability and durability of roads by enhancing the properties like stability, flow value, air voids, specific gravity, making it a very effective step towards eco-friendliness compared to conventional and traditional techniques of flexible pavements construction.

II. MATERIAL AND METHODOLOGY:

2.1 Aggregates:

Construction aggregate, or simply aggregate, is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Due to the relatively high hydraulic conductivity value as compared to most soils, aggregates are widely used in bituminous mix. The following is the aggregate gradation for the **DBM-2 (Dense Bituminous Macadam Grade 2)**, and accordingly the aggregate sizes were selected

TABLE I Gradation of Aggregate for DBM Gr.2

Sieve (mm)	37.5	26.5	19	13.2	4.75	2.36	0.3	0.075
% passing	100	95	83	68	46	35	14	5

2.2 Bitumen:

Asphalt, also known as bitumen is a sticky, black and highly viscous liquid or semi-solid form of petroleum. It may be found in natural

deposits or may be a refined product. The primary use (70%) of asphalt/bitumen is in road construction, where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete. Its other main uses are for bituminous waterproofing products, including production of roofing felt and for sealing flat roofs. The bitumen selected for the study is **VG-30 (Viscous Grade)** and is selected from the following gradation

TABLE II Gradation of bitumen

Lowest daily mean air temperature, °C	**Highest daily mean air temperature, °C**		
	Less than 20°C	20-30°C	More than 30°C
More than 10°C	VG-10	VG-20	**VG-30**
10°C and lower	VG-10	VG-10	VG-30

2.3 Plastic Waste:

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow. It is used in our daily life buckets, cellphones, windows etc. It is almost used in each and every product in our day to day life.

From various types like HDPE(High density polyethylene), polystyrene, polypropylene, LDPE(Low density polyethylene), etc.. We have selected LDPE(Low density polyethylene) for our study.

TABLE III Physical properties of Aggregate

Property	**Test**	**Specification**	**Result**	**Method of test**
Particle Shape	Flakiness and Elongation Index	Max.35% (Combined)	**26.88%**	IS:2386 (Part I)
Strength	Los Angeles Value	Max. 35%	**18.64%**	IS: 2386 (Part IV)
	Aggregate impact Value	Max. 27%	**21.18%**	
Water Absorption	Coarse Aggregate	Max. 2%	**1.49%**	IS:2386 (Part III)
Specific gravity	Coarse Aggregate	2.5 - 3.0	**2.80**	IS:2386 (Part III)
	Fine aggregate	2.5 - 3.0	**2.92**	
	Filler	2.5 - 3.0	**2.71**	

TABLE IV Physical properties of Bitumen

Property	**Test**	**Specification**	**Result**	**IS code**
Penetration	Penetration test	60 - 70	**85.33**	IS 1203-1978
Softening point	Softening point test	40°C - 50°C	**45.5°C**	IS 1205-1978
Ductility	Ductility test	75-90	**77 cm**	IS 1208-1978
Specific Gravity	Specific gravity test	0.97-1.02	**1.01**	IS 1202-1978

2.3 Optimization of Mix

Marshall mix design procedure is normally used to find out the optimum binder content for the

DBM-2 grading. The laboratory specimen were prepared using fifty blows of the Marshall

hammer per side. For finding OBC the Marshall mix specimen was tested for 4.5%, 5%, 5.5% (by weight of mix) of bitumen content. The optimum binder content was found to be 4.75% (by weight of mix) at 4% air voids.

2.4 Preparation of specimen for DBM Gr.2:

An optimum binder content was found to be 4.75% from Marshall control mix design (by weight of mix) and was used in preparing the modified

bituminous mix with addition of plastic so as to maintain the consistency throughout the study. The process followed for preparation of plastic modified mix was dry process of adding plastic.
The following steps were performed for formulation of the compacted specimen:
2.4.1 Graded aggregate were heated at 150 – 160 ºC in an oven and waste plastic in shredded form varying from 4% - 8% at an increased rate of 2% was added into the hot aggregate before mixing at optimum binder content in dry process.
2.4.2 The bitumen was heated at 160ºC on the hot plate before mixing.
2.4.3 The combination of plastic coated aggregate and bitumen were mixed uniformly at a mixing temperature of 150ºC ± 5ºC.
2.4.4 The specimen formulated were then compacted giving 50 number of blows at 150ºC using the Marshall apparatus.

3. Results and Discussions:

3.1 The variation of Marshall properties with % plastic are given tin the following table:

TABLE V Marshall Parameters for Various Plastic Contents

% Binder	Bulk Density Avg. (g/cm^3)	%Va Avg. (%)	VMA Avg. (%)	VFB Avg. (%)	Stability Avg. (kN)
4.5	2.574	4.50	13.18	65.85	6.475
5	2.576	3.52	13.56	74.07	6.300
5.5	2.575	2.47	14.05	82.52	6.265

3.2 Following are the graphs showing variation of Marshall properties with % plastic content:

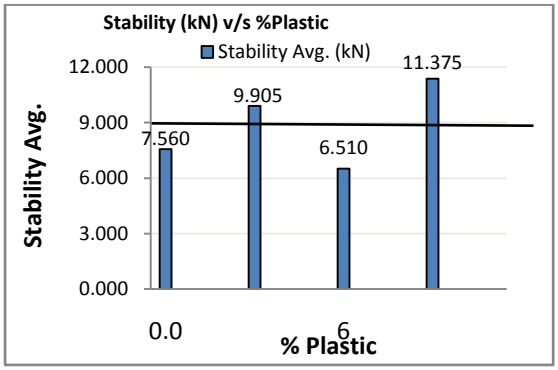

Fig. 1

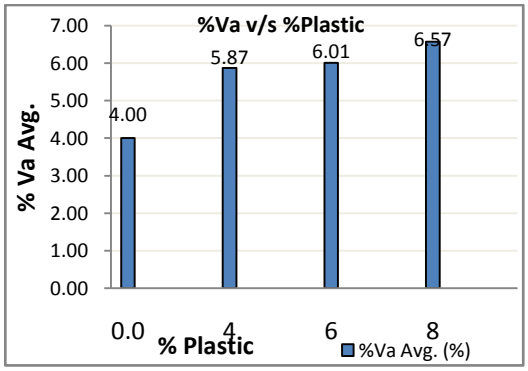

Fig. 2

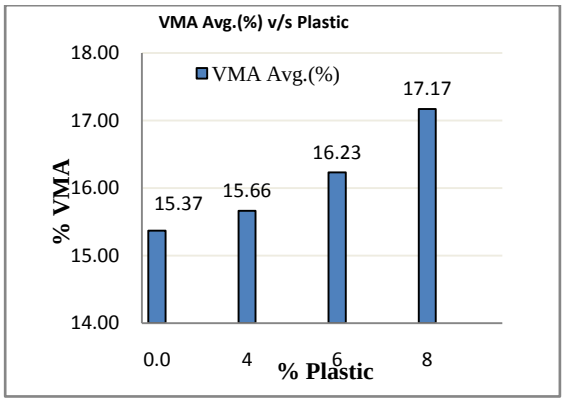

Fig. 3

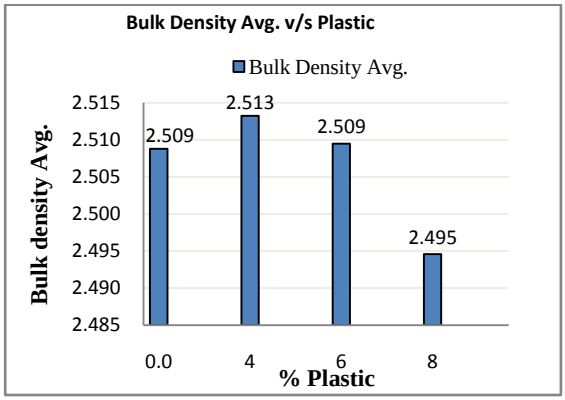

Fig. 4

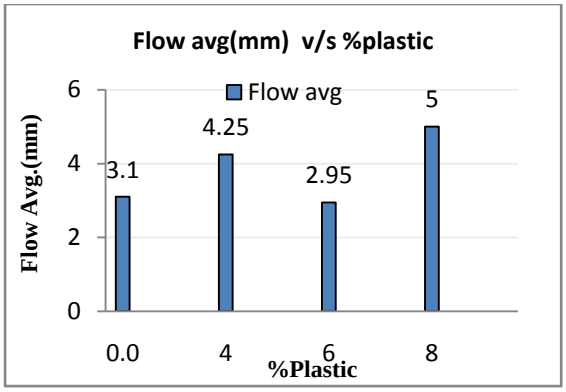

Fig. 5

From the results obtained graphs were plotted for the comparison of the conventional and modified bituminous mix. The stability vs plastic content graph shows that there has been increased for 4 and 8 percentage of plastic due the improvement in the interlocking between the aggregate and binder. The voids percentage is increasing within increase in the plastic content because of the increase in the bulk density which gives proper interlocking. VMA (voids in mineral aggregate) shows an increasing trend as the plastic content is increased, on the other hand the bulk density is seen to decrease with in increasing plastic content as the specific gravity of LDPE is less than that of aggregates. The flow value has been increased as compared to that of the conventional mix. VFB (voids filled with bitumen) increase to a certain value and then further decreases.

III. CONCLUSION:

Based on the analysis and results of this research, 4% plastic content is found to be the optimum percentage for use in bituminous mix. The addition of 4% LDPE has helped in improving the marshal stability value up to 4% and after that the graph shows reverse results, this is due the improvement in the interlocking of the aggregates. The bulk density of 4% plastic content is found to be highest as the interlocking between aggregates is good for this plastic content.The percentage voids for 4% plastic content is also highest as the bulk density for 4% plastic content is highest.

As a result it can be conclude that for Optimum Binder Content(4.75%) the most suitable plastic content is concluded as 4%. The results show improvement in the marshallstability, specific gravity, air voids and flow values for 4% plastic content which improves the service life and stability of pavement. In addition to this the reuse of waste plastic in this process helps to reduce the load on the recycling plants and also reduce the environmental impacts caused due to plastic waste disposal by various methods, indirectly helping reduce environmental damages.

REFERENCES:

Journal papers:

[1]. Amir Modarres, "Effect of waste plastic bottles on stiffness and fatigue properties of modified asphalt mixes", Elsevier journal (2014) 8-14

[2]. AmbikaBehl, Girish Sharma, GajendraKumar"ASustainableapproach:Utilization of waste PVC in asphalting of roads", Elsevier journal (2014) 113-117

[3]. Changqing Fang, Pei Liu, Ruien Yu, Xiaolong Liu, "Stability effect in waste polyethylene-modified bitumen", Elsevier journal (2014) 320-325.

[4]. EsmaeilAhmadinia , MajidZargar, Mohamed Rehan Karim, MahrezAbdelaziz, PayamShafigh, "Using waste plastic bottles as additive for stone mastic asphalt"**,** Elsevier Journal (2011) 4844-4849

[5]. Imran M. Khan, ShahidKabir, Majed A. Alhussain, Feras F. Almansoor, "Asphalt Design using Recycled Plastic and Crumb-rubber Waste for Sustainable Pavement Construction", Elsevierjournal (2011) 322-330

[6]. M. Naskara, T.K. Chakia, K.S. Reddyb,"Effect of waste plastic as modifier on thermal stability and degradation kinetics of bitumen/waste plastics blend",ElsevierJournal (2010) 128-134

[7]. R. Vasudevan, A. Ramalinga Chandra Sekar, R. Velkennedy, B.Sundarkannana,"Technique to dispose waste plastin in ecofriendly way", Elsevierjournal (2012) 311-320

[8]. SevilKöfteci, PervizAhmedzade, BaurzhanKultayev, "Evaluation of bitumen modified by various types of waste plastics", Elsevierjournal (2014) 592-602

[9]. SinanHınıslıoglua, EmineAgarb, "Use of waste high density polyethylene as bitumen modifier in asphalt concrete mix", Elsevierjournal(2004) 267-271

IS CODES:

[10]. IS: 1202 – 1978 Indian standard Methods for testing tarand bituminous materials: determination of specific gravity.

[11]. IS: 1203 - 1978 Edition 2.2 (1989-03) Indian standard Methods for testing tarand bituminous materials: determination of penetration.

[12]. IS: 1205 – 1978 Indianstandard Methods for testing tar and bituminous materials: determination of softening point.

[13]. IS: 1208 - 1978 Indian StandardMethods for testing tar and bituminous materials: Determination of ductility.
[14]. IS: 2366 (Part IV) - 1963 IndianStandardMethods of test for aggregates for concrete (Part iv mechanical properties)
[15]. IS: 2386 (Part I) - 1963 IndianStandardMethods of test for aggregate for concrete (Part i particle size and shape).
[16]. IS: 2386 (Part III) - 1963 IndianStandardMethods of test for aggregates for concrete (Part iii specific gravity, density, voids, absorption and bulking)

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