Construction of Road Pavement using Waste Plastic

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Abstract- Today availability of the waste plastics is enormous, as the plastic materials have become part of daily life. They neither get mixed with Municipal Solid waste nor thrown over land area. Their present disposal is either by land filling (or) by incineration. Both the processes are not Eco friendly. Under this circumstance, an alternate use for the waste plastics is also the need of the hour. The results indicate that binder content, test temperature and asphalt mix type are factors that significantly affect abrasion loss. Porous asphalts are more prone to abrasion loss due to its high air voids which results in lesser adhesion between aggregate particles. This study also shows that the abrasion loss sensitivity of VG30 mix is less influenced by the temperature and different binder types. In contrast, the resistance to abrasion loss of porous asphalt is very much affected by temperature variations. Rutting analysis should be carried out under various temperature conditions and wheel loads of different intensities to evaluate performance and strength.The aggregate gradations may be varied to check for the maximum performance of the mixes with coarser aggregates and maximum porosity.Anti-Stripping agents may be utilized to minimize the stripping of aggregates in the mixes.An Investigation on optimum plastic content and other additives which increases the binder property should be given importance.

Keywords: Road Pavements, Waste Plastic.

I. INTRODUCTION

A bituminous pavement has some advantages for road users and road side environments, e.g. improving drainage function.The application of bituminous pavement is also to provide skid resistance, especially in the wet season.Bitumen is a useful binder for road construction and different grades of bitumen like 30/40, 60/70 and 80/100 are available.The steady increase in high traffic intensity in terms of commercial vehicles, the significant variation in daily and seasonal temperature demand improved road characteristics.Plastomeric substances like polyethylene, EthyleneVinyl Acetate and Ethylene Butyl Acrylates are mixed with bitumen to modify the properties.

Disposal of waste material including waste plastic is a menace and has become a serious problems like:

1 Dumping the dustbins, clogging of drains, reduced soil fertility & aesthetic problem etc..causing environmental pollution.
2 The laboratory studies conducted by CRRI in utilization of waste plastic in bituminous concrete mixes. The results indicated that there was an improvement in strength properties when compared to a conventional mix.

Therefore, the life of pavement is expected to increase.

II. SYSTEM MODEL

TABLE 1:SPECIFIC GRAVITY OF AGGREGATES:

Sl. No.	Type of Aggregates	Specific Gravity
1	Coarse aggregate	2.609
2	Fine aggregate	2.679
3	Filler Material	2.514

Proportioning of the Mineral Aggregate Blend:

The aggregate used must be in such a proportion such that the sieve analysis of the aggregate produces blends acceptable as per the ranges given in table 3, which is as per MORTH specification.

Gradation to be obtained:

The different sizes of aggregates i.e. 20mm, 12.5mm, 10mm, 6mm and dust are selected from the heap and the sieve analysis is done to obtain the individual gradation of these aggregates. Then by ROTHFUTCH'S trial and error method, by using the Microsoft excel, the desired gradation for bituminous concrete (BC grade-II) has been obtained to match the midpoint gradation and is shown in table.

TABLE 2: PROPERTIES OF AGGREGATE

Sl No	Properties	Test method	MORTH Specifications	Obtained Values
1	Impact Value	IS-2386 Part- IV	10-30%	27.03%
2	Crushing Value	IS-2386 Part- IV	Max 30%	25.59%
3	Abrasion Value	IS-2386 Part- IV	30-40%	34%
4	Water Absorption	IS-2386Part-III	Max 2%	1.20%
5	Flakiness Index	IS-2386 Part- I	Max 40%	23.67%
6	Elongation index	IS-2386 Part- I	Max 15%	23.46%

TABLE 3 : SHOWING MORTH SPECIFICATION

Sieve Size mm	Combined Grading	Upper Limit	Lower Limit
37.5	100	100	100
26.5	98.34	90	100
19	85.82	71	95
13.2	76.1	56	80
4.75	42.26	38	54
2.36	37.12	28	42
0.3	12.38	7	21
0.075	2.8	2	8

TABLE 4 : GRADATION FOR BC GRADE-II

Sieve Size mm	Percentage Passing			Combined Grading	Specified Limits
	25 mm Down	10 mm Down	Stone Dust		
37.5	100	100	100	100	100
26.5	92.77	100	100	98.34	90 -- 100
19	38.35	100	100	85.82	71 -- 95
13.2	0.2	97.3	100	76.1	56 -- 80
4.75	0	1.23	99.6	42.26	38 -- 54
2.36	0	0.15	88.26	37.12	28 -- 42
0.3	0	0.1	29.39	12.38	7 -- 21
0.075	0	0.05	6.62	2.8	2 -- 8
% material	23	35	42	100	-

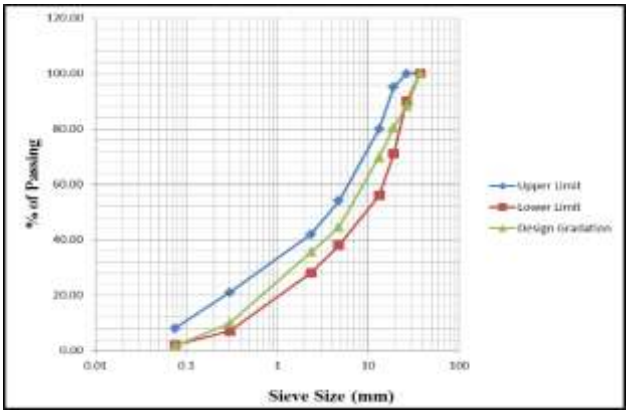

FIGURE 1: SHOWING THE OBTAINED GRADATION

The bituminous mixes are subjected to several tests as listed below to evaluate the performances. The tests are Marshall Stability, Indirect Tensile Test, Cantabro Loss test for air cured and water cured samples and Permeability tests. The Results of various tests for different mixes are presented in the following tables. Table 6 shows the results conducted for VG30 mix type

TABLE 5: TEST RESULTS FOR PA 14

Bitumen content	VG-30	WPMB
OBC	4.80%	4.90%

DATA COLLECTION

Marshall Stability Test:

TABLE 6: MARSHALL VALUES FOR VG-30

Sl. No.	Properties of VG-30 (TABLE 4.1)	Results	MoRT&H Specifications
1	Optimum Binder content in (%) by Weight of mix	4.8	4.5 Min
2	Stability in (Kg)	1600	900
4	Flow in (mm)	4	2—4
5	Bulk Density in (gm/cc)	2.38	--
6	Volume of Air Voids in (%)	4	3 – 6
7	Volume in Mineral Aggregate in (%)	16	13 min
8	Volume of voids filled by Bitumen in (%)	74	65 – 75
9	Marshall Quotient	400	--

The various data collected in Marshall Test like percentage of air voids, Stability etc. are given in the following tables. After conducting the Marshall test the density and void ratio is found out using the stability and flow values. The OBC is usually taken as the average if maximum stability value, 4% air voids & Binder content corresponding to maximum bulk specific gravity (Gm). Table shows the OBC values of various binder contents

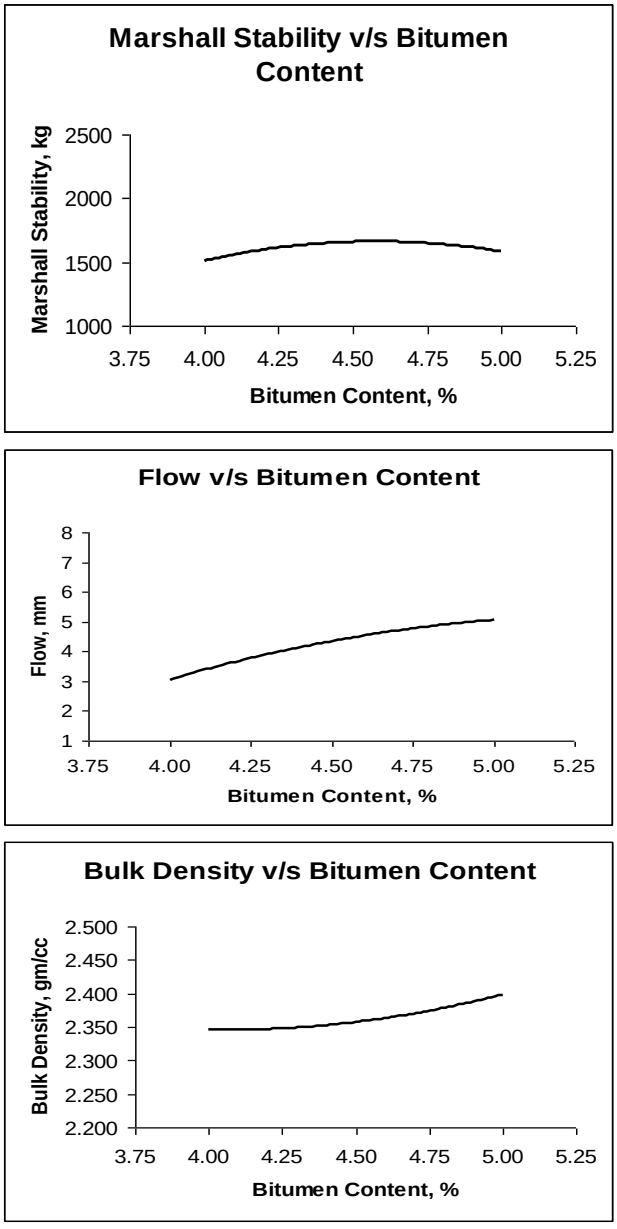

FIGURE 2: MARSHALL GRAPHS FOR VG-30

DATA ANALYSIS

Marshall Stability:

By the results obtained from the Marshall Stability test it is known that all the mix types (PA-14, PA-20 and PA-14 HS) performs well with the Air Voids ranging from 15% to 19% and stability is satisfactory ranging between 700 to around 2000 Kg. The comparison of stability over the three different mix types is presented below.

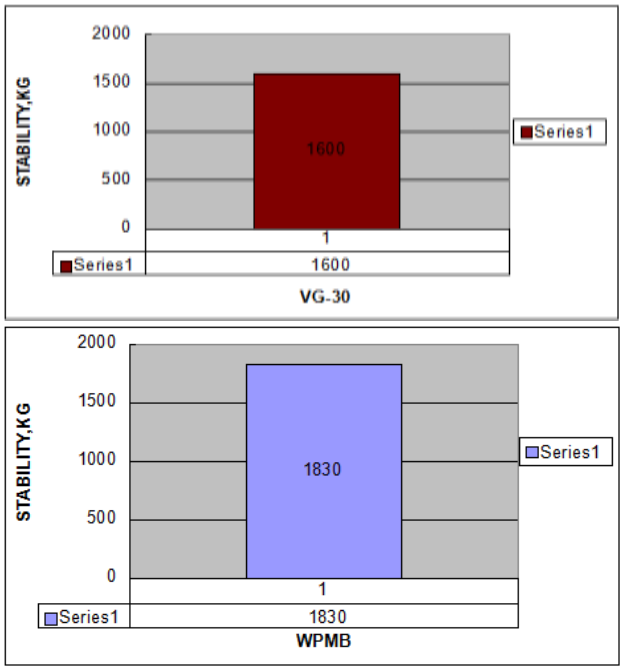

FIGURE 3: STABILITY CHART OF DIFFERENT MIX TYPES

By the above stability chart it is known that the performances of WPMB and CRMB porous asphalt mixtures with different mix designations performed better against the mixes prepared with the conventional VG-30 bitumen type. The stability of PA-20 mix is less when compared to other two mixes since the voids ratio and presence of coarse aggregates above 13.2mm sieve sizes. The stability of the mixes prepared using the modified binders are greater because of the improvements in the cohesion in the mixes. But the PA-14 HS performance was more because the fines content in this mix is more when compared to PA-14 mix which induces better interlocking between the aggregates within the mixes. However the stability of the mixes with modified binders is satisfactory and the PA-14 HS mix yielded greater stability with various binders used.

III. PREVIOUS WORK

Research by M.O. Hamzah, M.R.M Hasan (2010), reported that, ravelling was simulated by subjecting a Marshall specimen in the Los Angeles drum to a certain number of rotations. The percentage loss of particles after the test gave an indication of the severity level of mix ravelling. The abrasion loss of porous and dense mixes was compared. The mixtures were prepared according to Spanish porous asphalt (PA-12) and Malaysian dense asphalt concrete wearing course (ACW14) gradation specifications. Both mixes were prepared using conventional 80/100 penetration bitumen and compacted using the Gyratory compactor. The mixtures were evaluated for abrasion loss property in the Cantabrian test at 3 different temperatures, 18°C, 24°C and 29°C. The results showed that the dense asphalt mixes exhibited higher resistance to abrasion loss compared to porous asphalt. In addition, higher abrasion loss took place for mixes prepared at lower binder contents and tested at lower temperatures.

Research done by Suresha.S.N, A.U. Ravi Shankar and Dr.VargheseGeorge (2007), consisted of literature review related to history of use of PFC's, mix-design methods, various performance properties, construction and maintenance aspects, and other characteristics of PFC's. The research works investigated the incorporation of wet mix rubberized asphalt to increase the performance of the porous bituminous mix. Here also their research is based on various mix design practices and comparison of OGFC and gradation practices in European countries.

Research work carried out by V.S Punith and A. Veerargavan 2007, made use of reclaimed polyethylene (PE) derived from low-density PE carry bags collected from domestic waste as an additive in bituminous mixes. Different ratios of PE (2.5, 5.0, 7.5 and 10% by weight of bitumen) were blended with 80/100 paving grade binder. The analysis of various test results show that performances of PE-modified mixtures are better when compared to conventional mixtures. They recommended that PE content of 5% weight of asphalt improves the performance of bituminous mixtures when compared to conventional mixtures.

IV. PROPOSED METHODOLOGY

Tests on binders performed during the study

BITUMEN TYPE

Bitumen – VG-30

Waste Plastic Modified Bitumen (WPMB-VG-30 and 8% shredded waste plastics)

TESTS ON BITUMEN.

- Penetration test (IS1203:1978).
- Softening point test (IS1205:1978).
- Ductility tests (IS 1208:1978).
- Viscosity tests (IS1206:1978).
- Flash and fire point tests (IS 1209:1978).
- Specific gravity tests (IS 1202:1978).

V. SIMULATION/EXPERIMENTAL RESULTS

The bituminous mixes are subjected to several tests as listed below to evaluate the performances. The tests are Marshall Stability, Indirect Tensile Test, Cantabro Loss test for air cured and water cured samples and Permeability tests. The Results of various tests for different mixes are presented in the following tables. Table 6.1 shows the results conducted for VG30 mix type.

TABLE 7: TEST RESULTS FOR PA 14

Binder Type	Marshall Stability, Kg
VG-30	1600
WPMB	1830

The results obtained in the above table shows the VG30 mix performs well in all the test starting from conventional binder to the modified binder. But the results of water abrasion loss are not satisfactory with the use of conventional type of binder, the water abrasion loss exceeds the limit value of 40%. According to Isabelle Skavarka, 1996 the maximum permissible water abrasion loss value is 40%. But the results of modified binders are well within the range in all types of tests. The major reason for the well performance of the mixes is the aggregate gradation where the coarse aggregates above 13.2mm sieve size is not present and percentage of fines are present is more. Hence there is a strong bond and interlocking between the aggregates results in increase in the performances of the mix. The other factor for better result is cohesive property of the modified binders.

TABLE 8. Shows the Test Results of the Binders at various Temperatures

Sl. No.	Properties	Test Method	Obtained Values for VG-30	Obtained Values for WPMB
1	Penetration (100g, 25°C, 5sec)mm	IS:1203 – 1978	52mm	38 mm
2	Softening point (^{o}c)	IS:1205 – 1978	53.76 ^{o}c	57 ^{o}c
3	Ductility in cm	IS:1208 – 1978	40cms	44cms
4	Specific gravity	IS:1202 – 1978	\0.99	0.98
5	Flash and fire point (°C)	IS:1209 – 1978	220^{o}C,275^{o} C	200^{0}C,2200 C

VI. CONCLUSION

Porous asphalt is characterized by high porosity and strong water permeability. Hence, it generally has a high macro roughness, a lower thermal conductivity and less contact points between the stones in comparison to the traditional dense graded mixes. The key point is to ensure cohesion and adhesion of the surface particles subjected to the mechanical loads. To this end, polymer modified and crumb rubber binders have been shown to improve the performance of porous asphalt. The results indicate that binder content, test temperature and asphalt mix type are factors that significantly affect abrasion loss. This study also shows that the abrasion loss sensitivity of VG30 mix is less influenced by the temperature and different binder types. The use of modified binders in the porous asphalt mix give some advantages for the mix performances i.e. increase the Marshall Stability and decrease the Cantabro Loss value.

VII. FUTURE SCOPES

The Following works can be done to see the performance of the porous asphalt mixes.

1. Rutting analysis should be carried out under various temperature conditions and wheel loads of different intensities to evaluate performance and strength.
2. The aggregate gradations may be varied to check for the maximum performance of the mixes with coarser aggregates and maximum porosity.
3. Anti-Stripping agents may be utilized to minimize the stripping of aggregates in the mixes.

An Investigation on optimum plastic content and other additives which increases the binder property should be given importance.

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