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Experimental Study of Crumb Rubber in Semi Dense Bitumen Concrete

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ABSTRACT: - *Crumb rubber modified bitumen (CRMB) has been identified as a special type of bitumen whose properties can be improved by the addition of crumb rubber, thus improving the physical properties of bitumen. This modifier makes bitumen more resistant to temperature variations, weather and high traffic loads; it reduces the maintenance costs and improves driving comfort. This paper reviewed the use of this modifier in pavement.*

Key words: - *Crumb rubber, Bitumen, modifiers, Pavements, Durability, Marshal*

I. INTRODUCTION

The road traffic and the traffic intensity are increasing. In India, it is estimated that over 36 lakh kilometers of path be present and about 40% of this path has been having good surface and maintained. Transportation through road now got a leading and high rank between the several present means of transportation arrangement as it is more comfortable and easy to use and more reliable with high speed. Almost 90% of total traffic in our county travels on road and 70% travels on freight transport. Thus the load bearing capacities of the road is to be increased. There are two types of roads - flexible pavements (bitumen roads) and rigid pavements (concrete roads)[3]. Flexible pavements (bitumen roads) comprise of the major portion of all surfaced roads. In India, bulks of the roadways are made up of bitumen, as they cost less in terms of initial cost when cost has been compared with the initial cost of rigid pavements which made up of cement concrete. Explorations in this and different countries overseas have exposed that properties influencing the characteristics of bituminous mixes were improved to congregate necessities of pavement with the insertion of persuaded additives or merge of additives. These additives can be called modifiers of bitumen and the bitumen mixed with these modifiers is recognized as modified bitumen. Modified bitumen is probable to provide superior life of surfacing (up to 100%) depending upon quantity of amendment and type of additives and modification development used. Modifiers which may be used can be Polymers, Natural Rubber and Crumb Rubber. Crumb Rubber Modified Bitumen (CRMB) is a special type of bitumen whose properties has been improved by the addition of crumb rubber and special types of additives like hydrocarbon additives, resins, etc., thus altering the physical properties of bitumen making it more resistant to temperature variations weather and high traffic loads, reduce maintenance costs and excellent driving comfort [4].

II. LITERATURE REVIEW

Conventional bituminous materials executed their role adequately in the majority of the pavements. On the other hand, presented highway systems were facing the enlarged traffic amount, elevated axle load, high tyre stress and severe environmental impacts. The circumstances were noticeable since the last 30 years, that the pavement was facing extra demands than earlier than resulting in necessitate for an improvement in the properties of bituminous materials. This chapter presents a brief review of literature on the topics related to bitumen additives, modified bituminous mixtures particularly using LDPE/CRMB modifiers, and engineering/rheological characteristics of bitumen and mixtures.

Yuqiao Yang at al (2016) three kinds of modified asphalt were prepared by adding waste crumb rubber (WCR), waste polyethylene (WPE), and WCR/WPE to base asphalt, respectively. 135°C, 165°C viscosity, was studied, and the modification mechanism of modified asphalt was discussed through 135°C viscosity of compound modified asphalt is better than that of WPE and WCR modified asphalt. In addition, the water proofness of compound modified asphalt using waterproofing materials is better than that of common waterproofing materials [1].

C. Prasanna kumar at al (2015) studied crumb rubber recycled rubber from automotive and truck scraps tires. During the recycling process steel and fluff is removed leaving tire rubber with a granular consistency. The Tyres obtained from Vehicles and other rubber materials which are available in the places. Now days there are lot of automobiles throughout the world as well as in India also to reduce the amount of usage of bitumen is very much essential, in this direction the study is important. They study involves the characteristics of the crumb rubber when used along with bitumen. The different tests are conducted[2].

Vasudevan et al 2007, studied plastic waste consisting of carry bags, cups and Thermopolis that can be used as a covering over aggregate and this covered stone can be

used for road construction. By this course a road of 1 km length and 3.375 m width of single lane can uses 10, 00000 carry bags and the road strength is increased by 100% and also there will not be any pot whole formation. Penetration was reduced to a very low value and similarly the ductility. It has been inferred that the use of higher percentage (more than 3%) of plastics in polymer modified bitumen is not favorable. The paper also studied use of crumb rubber waste as bitumen modifier. Waste tyres were powdered and the powder is blended with bitumen (80/100) heated to 100-120oC and stirred at speed of 3000 rpm for 2-3 hours. This blend was used along with plastic coated aggregate. The mix polymer coated aggregate and tyre modified bitumen have shown higher strength. The percentage of crumb rubber modifier in the mix varies from 1% to 5%.The work done by Vasudevan et al (2007) is similar to this work. However this work differs from Vasudevan et al (2007) in that used LDPE/CRMB on SDBC, used different grade bitumen and taken higher percentage of modifier w. r. t. the bitumen weight [5].

III. RESEARCH AND EXPERIMENTAL PROGRAM

Laboratory experiments were conducted on the conventional bitumen (60/70) and modified bitumen samples. Individual properties (Penetration, Softening Point, Ductility, Flash and Fire, and Specific Gravity) of the sample were determined. Using the Marshal Mix design characterization of conventional bituminous mix (60/70) for Semi dense bituminous mix (SDBC) were carried out and comparison was made for conventional bitumen mix properties with modified bitumen. After determining factors to be considered for modeling modified bitumen in bituminous mix, a detailed plan for the experimental program (sample preparation and lists of tests) was developed. We Perform test are Penetration test, Ductility test, Softening point test, Specific gravity test, Flash and fire point test, Marshal Stability test.

IV. RESULTS AND DISCUSSIONS

This chapter deals with results obtained for penetration, softening, ductility, flash and fire and specific gravity tests on 60-70 grade Bitumen and modified bitumen. Also the results obtained from Marshal Stability test, on various samples for Semi Dense Bituminous Concrete (SDBC).Ministry of Road, Transport and Highways (MORTH) which provides specifications for all roads and bridge works. In this chapter experimental results are compared with MORTH specifications for Semi Dense Bituminous Concrete (SDBC). According to MORTH specification, SDBC should have following characteristics as specified in table 1 and 2.

Table: 1 result obtained from marshal stability mix design for SDBC with 60/70 grade bitumen

S. No	Bitumen	MS	FV	BV	AV	VMA	VFB
	%	(kg)	(mm)	(gm/cc)	(Vv) %	%	%
1	4	830	2.7	2.234	4.86	13.82	60.2
2	4.5	870	3	2.246	4.32	13.9	71.1
3	5	967	3.12	2.262	3.76	13.92	73.6
4	5.5	872	3.53	2.248	3.24	14.08	74.1
5	6	840	3.94	2.231	3.07	14.33	76.2
*FV= Flow Value		*MS =Marshal Stability			*BV= Bulk Value		
*BD = Bulk Density		*AV = Air Voids					

Table2: It is therefore inferred that 9% CRMB admixture saves bitumen content, Without adversely affecting Marshal Stability Value.

S. No	Bitumen	sample (gm)		stability	Value	Density	Voids	VMA	VFB
	%	Air	Water	(kg)	(mm)	(gm/cc)	%	%	%
1	3.5	1198	655	1230	2.58	2.19	4.83	13.46	65.6
2	4	1186	675	1275	2.86	2.24	4.56	13.93	68.2
3	4.5	1194	693	1320	3.15	2.32	4.18	14.37	70.7
4	5	1176	69	1340	3.3	2.34	4.2	14.82	70.9
5	5.5	1183	682	1355	3.35	2.36	4.22	15.17	71.9
6	6	1176	690	1360	3.39	2.38	4.07	15.23	72.9
7	6.5	1183	682	1335	3.57	2.3	3.89	15.34	74.9

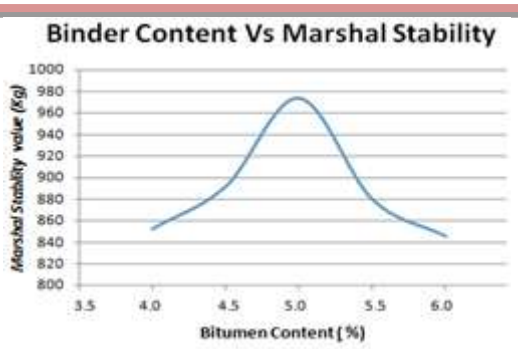

Figure1: Bitumen % Vs Marshal Stability Value

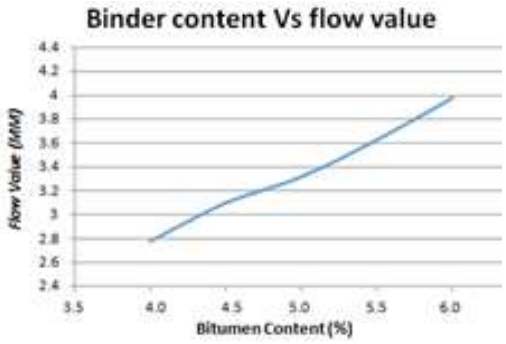

Figure 2: Bitumen %Vs Flow value

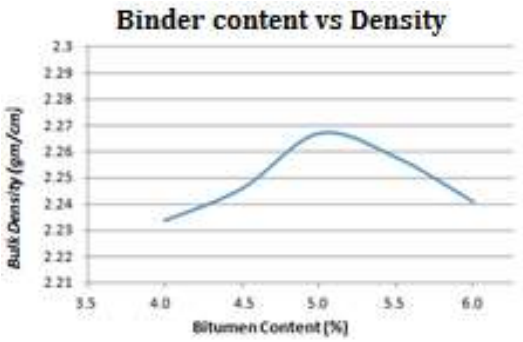

Figure3: Bitumen % Vs density

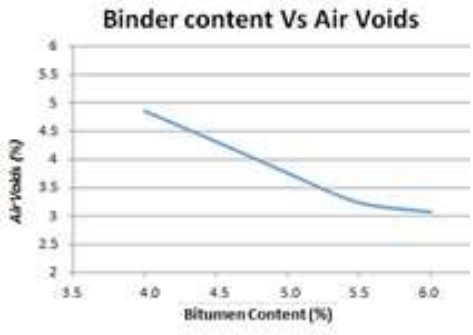

Figure4: Bitumen % Vs Air voids %

V. CONCLUSIONS & SCOPE

It has been observed that when the crumb rubber is mixed with 60/70 grade bitumen with varying (3, 6, 9 and 12) % the penetration value, ductility, flash and fire, specific gravity and softening point changed. As discussed earlier in chapter 4 it is shown in all experiments that the penetration, ductility decreased and softening point and specific gravity values are increased.

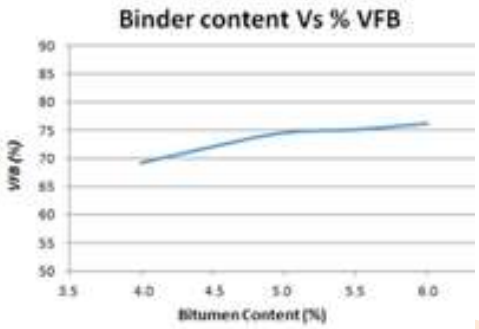

Figure5: Bitumen % Vs Voids filled with bitumen

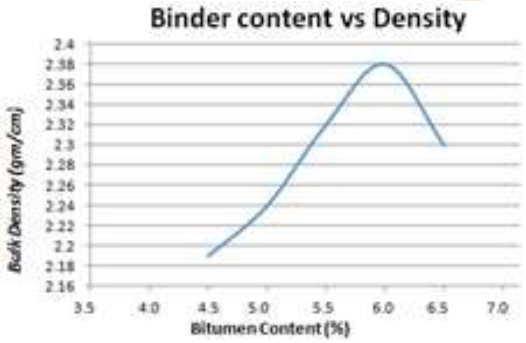

Figure6: Bitumen % Vs Marshal Stability Value

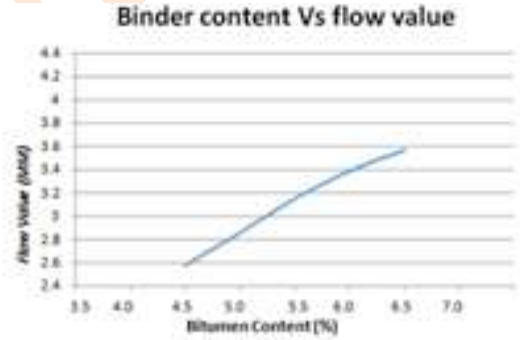

Figure7: Bitumen %Vs Flow value

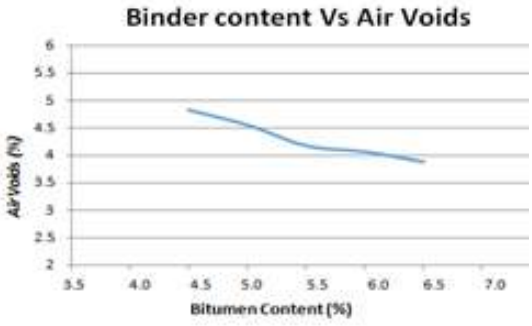

Figure8: Bitumen % Vs Air voids %

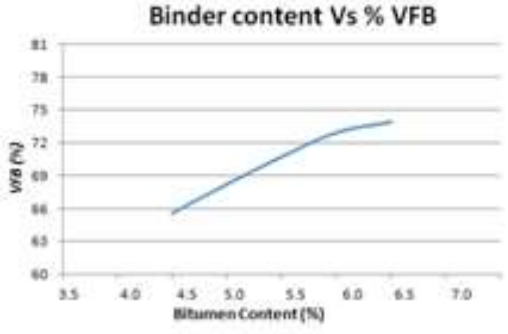

Figure9: Bitumen % Vs VFB %

AS the % of CRMB increases the penetration and ductility decreases more and softening point and specific gravity values increases more. While in the case of flash and fire point values first it increases and then decreases for increasing % of CRMB. The following conclusions are drawn from the present study. Analysis of this study observed that the Marshal Stability values and flow value of bituminous mix are increased due to addition of CRMB. CRMB modified bitumen higher marshal stability value is obtained when 9% CRMB is added to the mix. CRMB Modified Bitumen mix shows better Marshal Stability value (1284 kg) than ordinary (60/70 grade) bituminous mix (967 kg). The Marshal stability value increases for CRMB 6%, 9%, 12% by 22.17%, 31.42%, 24.22% respectively at 6.00% bitumen (60/70 grade) content. It is also observed that the air voids decreases which are good for strength and life of the road and the VFB (void filled with bitumen) is increased by % of bitumen. Optimum binder content reduces to 5% with optimum dose of CRMB (9%) in comparison to ordinary bituminous mix (6%). In present study work is done on semi dense bituminous concrete for 60/70 grade bitumen and modified with addition of CRMB for different percentage. In future modifiers are changed such as Natural rubber, Latex powder, waste polymer, HDPE additives to modify bitumen could be considered. Use of LDPE, CRMB and LDPE + CRMB and CRMB+HDPE can be used for dense bituminous concrete and bituminous concrete also.

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