International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 4, Issue 01, January-2018

Experimental Study Of Modified Bitumen With Crumb Rubber (CRMB) And Low Density Polythene (LDPE)

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Abstract-*The most important and widely used material in the construction of pavement is Bituminous concrete. It consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together & laid down in layers then compacted. This dissertation presents a research of modification of bitumen mix by use the different materials for preventing the damage of pavement and conducted to experimental study use of waste plastic, low density polyethylene (LDPE) and crumb rubber (CRMB) for the design of bituminous mixes at the different mix design characteristics and for conventional bitumen (60/70). The dry and wet process used to find the optimum % of bitumen content.*

When the crumb rubber and polythene mixed with varying percentage (3, 6, 9 and 12) and (2, 4, 6 and 8) to the 60/70 grade bitumen their optimum values are 9 % (for CRMB) and 8% (for LDPE) respectively. After combination of these materials with their optimum value with bitumen the Marshall Stability value has observed. The optimum binder content reduce to 5.25% with the combination of optimum dose of CRMB i.e., 9% and optimum dose of LDPE i.e. 8% respectively compare to ordinary bituminous mix i.e., 5.5%.

Keywords- *Crumb Rubber, Low Density Polyethylene (LDPE), Bituminous Concrete, Marshall Properties, Semi Dense Bituminous Macadam (SDBM).*

1. INTRODUCTION

1.1 Genral

In India, road transport carries close to 80% of passenger traffic and 70% of freight transport. In India, majority of the pavements are bituminous concrete i.e. flexible pavement since they consume lesser initial cost when compared with rigid pavements i.e. cement concrete pavements. Investigation in India and other countrieshave revealed that properties of bitumen and bituminous mixes can be improved for the requirement of pavement with the certain additives. These blended additives with bitumen are called“Bitumen Modifiers” and the bitumen blend with these modifiers is called “Modified Bitumen”. Different types of modifiers used are Polymers, Natural Rubber and Crumb Rubber.

1.2Modified Bitumen

Use of LDPE (Low density Poly-ethylene), crumb rubber in bitumen and bitumen mixes of SDBC(Semi dens Bituminous Concrete). Modification of bitumen by the addition of polymers can lead to significant changes in the mechanical properties of the bitumen. To utilize the non- biodegradable material which is otherwise a threat to the environment, in highway bituminous mixes substantially improving the stability or strength, fatigue life and other desirable properties of bituminous mix. Therefore the life of the flexible pavement surface course using the modified bitumen is also expected to increase strength in comparison to the use of ordinary bitumen.

1.3 Crumb Rubber (CRMB) 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 to improve for resistant the temperature variations in weather and heavy traffic loads and reduce the maintenance costs and excellent driving comfort.

1.4 LDPE (low density poly-ethylene) Modified Bitumen

Poly-ethylene modified bitumen is emerging as one of the important construction materials for flexible pavements. Use of waste plastic in the construction of flexible pavement is gaining importance because of the several reasons. The polymer modified bitumen show better properties for road construction & plastic waste, otherwise considered to be a pollution menace, can find its use in this process and this can help solving the problem of pollution because most of the plastic waste is polymers.

2. OBJECTIVE OF PRESENT RESEACH

There are following significant objectives of present experimental work:-

1. To Review the relevant Literature.
2. To study the physical properties of 60/70 grade bitumen and with the varying percentage of CRMB.
3. To analyze the engineering properties of modified bituminous mix using elastomer (CRMB) and (LDPE) in varying percentage for Semi Dense Bitumen Concrete (SDBC).

3. LITERATURE REVIEW

1. Rokade S (2012) prepared SDBC (Semi Dense Bituminous Concrete) mix using Marshall Method of bituminous mix Design. The SDBC mix was prepared with 4.5to6%incrementof 0.5% bitumen. This study used LDPE Low Density Polyethylene and CRMB Crumb rubber modified bitumen 3% increment of the (LDPE) for 3%, 6%, 9% and CRMB used for 8%, 10% ,12% respectively by weight of bitumen.The study on the use of LDPE and CRMB reveals that the Marshal Stability value, which is the strength parameter of SDBC has shown increasing trend and the maximum values have increased by about 25 % by addition of LDPE and CRMB. The density of the mix has also increased in both the cases of LDPE and CRMB when compared with60/70gradebitumen.
2. Vasudevan et al (2007) Plastic waste consisting of carry bag, cup can be used as a coating over aggregate and this coated stone can be used for road construction. Penetration was to a very low and similarly the ductility. Waste tyre are powdered and the powder is blended with bitumen heated 100-120 and stirred 2-3 hours. This blend is 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%.
3. Shankar et al (2009) crumb rubber modified bitumen (CRMB) was added at specified temperature. Bituminous concrete mix design was mix design was carried out by changing the modified bitumen content at constant rubber content and subsequent tests have been performed to determine the different mix design characteristic when compared with straight run bitumen at that too at reduced.
4. Mohammad T. Awwad and Sheeb Lina. (2007) worked out polyethylene as one sort of polymers used to investigate the potential prospects to enhance asphalt mixture properties. The objectives also include determining the best type of polyethylene to be used and its proportion. Two types of polyethylene were added to coat the aggregate High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE). The results indicated that grinded HDPE polyethylene modifier provides better engineering properties. The recommended proportion of the modifier is 12% by the weight of bitumen content. It is found to increase the stability, reduce the density and slightly increase the air voids and the voids of mineral

aggregate.

5. Panda and Mazumdar (2002) Utilized reclaimed polyethylene obtained from LDPE carry bags to modify asphalt cement. They studied the basic properties such as Marshall Stability, resilient modulus, fatigue life, and moisture susceptibility of mixes with 2.5% of PE and compared with those of asphalt cement. They concluded that at a particular temperature and stress level, polymer modification increases the resistance to moisture susceptibility and fatigue life of mixes.

4. EXPERIMENTAL PROGRAME

The Semi Dense Bituminous Concrete (SDBC) mix was prepared using Marshall Method of bituminous mix design. The SDBC was prepared with conventional 60/70 grade bitumen, 60/70 grade bitumen added with varying percentages of LDPE and Crumb Rubber and 60/70 grade bitumen is also added with combination of both modifier. The details of the experimental programme are as follows.

Table 1 Detail of Sample Constitution and Percent Constituents

Sample Constitution	Sample Preparation	% Constituent by Weight of Bitumen
60/70 Grade bitumen	Wet Process	----------

Bitumen + CRMB	Wet Process	CRMB: 3%
		CRMB: 6%
		CRMB: 9%
		CRMB: 12%
Bitumen + LDPE	Dry Process	LDPE: 2%
		LDPE: 4%
		LDPE: 6%
		LDPE: 8%
Bitumen +LDPE+CRMB	Dry +Wet Process	Optimum Value of CRMB + LDPE

3.1 Ministry of Road Transport and Highways Specifications forSDBC

Ministry of Road, Transport and Highways (MORT&H) has provided specifications for road and bridge works. The specifications for SDBC are as follows:

Table 2 Specifications for SDBC

S. No.	Parameter	Specified Limits
1	Minimum stability (Kg at 60oC)	820
2	Minimum flow (mm)	2
3	Maximum flow (mm)	4
4	Compaction level (Number of blows)	75 blows on each of the two faces of the specimen
5	Percent air voids	3-5
6	Per cent voids filled with bitumen (VFB)	65-78

5. RESULT AND DISCUSSION

The SDBC was prepared by Marshall method using the 60/70 grade bitumen and the various mix design characteristics of the Marshal stability value, Flow value, Bulk Density, Air Voids (Vv) , Voids in mineral aggregate (VMA) , Voids filled with bitumen(VFB) were found out. The results are shown in table 2.

Table 3. Results of SDBC Mix Design using 60/70 Grade Bitumen

S. No	Bitumen %	Marshal stability (Kg)	Flow value (MM)	Bulk Density (gm/cc)	Air voids % Vv	VMA	VFB %
1	4.50	853	2.78	2.234	4.86	14.84	69.23
2	5.00	892	3.10	2.246	4.32	14.95	72.12
3	5.50	974	3.32	2.267	3.76	14.98	74.58
4	6.00	880	3.63	2.258	3.24	15.06	75.14
5	6.50	846	3.98	2.241	3.07	15.29	76.24

The results show that with 5.5% bitumen content higher value of Marshall Stability value and greater density was achieved. All other parameters were also well within the specifications of MORT&H. Hence with 5.5% bitumen content of 60/70 grade bitumen varying percentages of LDPE and Crumb Rubber was added and SDBC mix was prepared. The results of SDBC mix with varying percentage of LDPE are shown in the followingtable:

Table 4. Results of SDBC Mix for Varying Percentages of LDPE

S. No	LDPE %	Bitumen %	Marshal stability (Kg)	Flow value (MM)	Bulk Density (gm/cc)	Air voids % Vv	VMA	VFB %
1	2%	5.5	1020	2.97	2.24	3.76	15.68	72.18
2	4%	5.5	1122	3.68	2.25	3.52	14.86	74.38
3	6%	5.5	1140	3.88	2.25	3.43	14.69	75.42
4	8%	5.5	1165	3.92	2.26	3.27	14.52	76.78

From the above results it is observed that Marshall Stability Values and Bulk Density increased with the percentage increase in the modifier (LDPE). Hence by addition of LDPE the strength characteristic of the mix was enhanced vis- a- vis when it was not mixed with 60/70 gradebitumen.

Table 5 shows the results of SDBC Mix for Varying Percentages of Crumb Rubber. The Crumb Rubber was added to 60/70 grade bitumen in varying percentage of 3%, 6% 9% and 12%. The SDBC mix was prepared with 5.5% bitumen and the varying percentages of Crumb Rubber. The bitumen when mixed with Crumb Rubber is termed as Crumb Rubber Modified Bitumen (CRMB).

Table 5. Results of SDBC Mix for Varying Percentages of Crumb Rubber

S. No	CRMB %	Bitumen %	Marshal stability (Kg)	Flow value (MM)	Bulk Density (gm/cc)	Air voids % Vv	VMA	VFB %
1	3%	5.5	1052	3.55	2.25	3.79	14.96	74.12
2	6%	5.5	1090	3.62	2.26	3.83	15.08	73.84
3	9%	5.5	1180	3.68	2.28	3.87	15.14	73.72
4	12%	5.5	1160	3.72	2.27	3.86	15.16	73.25

From the above results it is observed that the Marshal Stability Value are increased from 3% to 9% Crumb Rubber and then it is decreased i.e 9% of Crumb Rubber of the weight of bitumen is the optimum dose for getting enhanced strength characteristics of SDBC mix. The bulk density also shows increasing trend from 3% to 12%. The values of other parameters are also within the required specificationlimits.

Table 6 shows the results of SDBC Mix with combination of optimum values of Crumb Rubber (CRMB) and Low Density Polythene (LDPE) for Varying Percentages of Bitumen Content. The Bitumen in varying percentage 4.75%, 5%, 5.25%, 5.5%.

Table 6. Results of SDBC Mix for Varying Percentages of Bitumen with Optimum Dose Of CRMB and LDPE

S. No	LDPE %	CRMB %	Bitumen %	Marshal stability (Kg)	Flow value (MM)	Bulk Density (gm/cc)	Air voids % Vv	VMA	VFB %
1	8	9	5.5	1270	3.25	2.24	3.04	15.05	77.28
2	8	9	5.25	1325	3.40	2.24	3.28	14.78	76.47
3	8	9	5	1310	3.52	2.23	3.76	14.47	71.32
4	8	9	4.75	1260	3.60	2.24	4.42	14.42	68.23

From the above result it is observed, The optimum binder content reduce to 5.25% with the combination of optimum dose of CRMB i.e., 9% and optimum dose of LDPE i.e. 8% respectively compare to ordinary bituminous mix i.e., 5.5%.

6. CONCLUSION

1. Analysis of this study observed that the Marshal Stability values and flow value of bituminous mix are increased due to addition of CRMB and LDPE.
2. Modified bitumen the higher marshal stability value is obtained when 9% CRMB and 8% LDPE is added to the mix.

3. Bituminous concrete content in normal mix at 5.5% bitumen content, the Marshall stability is 974 kg.
4. When bituminous concrete with 8% of LDPE at 5.5% of bitumen content the Marshall Stability value is 1165 kg, which is 19.60% more than to the normal mix.
5. When bituminous concrete with 9% of CRMB at 5.5% of bitumen content the Marshall Stability value is 1180 kg which is 21.15% more than to the normal mix.
6. When bituminous concrete with the combination of 9% of CRMB and 8% of LDPE at 5.5% of bitumen content the Marshall Stability value is 1325 kg which is 36.04% more than normal mix.
7. 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.
8. Optimum binder content reduces to 5.25% with optimum dose of CRMB (9%) + LDPE (8%) with the comparison to ordinary bituminous mix (5.5%).

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