Influence of Modify Bituminous Mix with Fly Ash

S.D.Katara, C.S.Modhiya, N.G.Raval

***Abstract*— Fly ash and waste tyre of vehicles is one of the most industrial waste residues in India. Fly ash is the main solid waste discharged by coal-fired power plant. In India, the annual emission of fly ash is more than 0.3 billion tons, and it is one of the main industrial waste residue. The use of four wheeler, two wheeler vehicles etc. is increasing day by day. As a result amount of waste tyres also increasing. Waste tyres in India are categorized as solid or hazardous waste. It is estimated that about 60 per cent of waste tyres are disposed via unknown routes in the urban as well as rural areas. This leads to various environmental problems which include air pollution associated with open burning of tyres and aesthetic pollution. Therefore, it is necessary to utilize the wastes effectively with technical development in each field. A good design of Modify bituminous mix is expected to result in a mix which is adequately strong, durable and resistive to fatigue and permanent deformation and at the same time environment friendly and economical. A mix designer tries to achieve these requirements through a number of tests on the mix with varied proportions of material combinations and finalizes the best one. The research result shows that the Marshal method of bituminous mix design was carried out for varying percentages of Fly ash to determine the different mix design characteristics.**

***Index Terms*— Fly ash, Modify Bitumen, Marshal Stability.**

I. INTRODUCTION

Fly ash is the main solid waste discharged by coal-fired power plant. In India, The annual emission of fly ash is more than 0.3 billion tons, and it is one of the main industrial waste residue. How to utilize the fly ash comprehensively is an important technical economic policy in India economic construction. In India, the expressway is in larger scale construction. The Bituminous concrete pavement is the most main pavement structure and the limestone mineral powder is often used as the filler in bituminous concrete. The limestone mineral powder produced will pollute to environment, and the price of limestone mineral powder is high for the great demand quantity. Early research result find that the fly ash has the similar physic-chemical characteristics with the limestone mineral powder. If the fly ash can replace the limestone mineral powder as filler in bituminous concrete partly or completely, that will produce large economic and environmental benefit High temperature stability is one of the most important pavement performances.

In India, it is estimated that over 33 lake kilometres of road exists. The road transport carries close to 90% of passenger traffic and 70% of freight transport. Investigations in India and countries abroad have revealed that properties of bitumen and bituminous mixes can be improved to meet requirements of pavement with the incorporation of certain additives or blend of additives. These additives are called "Bitumen Modifiers" and the bitumen premixed with these modifiers is known as modified bitumen. Modified bitumen is expected to give higher life of surfacing (up to 100%) depending upon degree of modification and type of additives and modification process used. Different types of modifiers used are Polymers, Natural Rubber and Crumb Rubber.

Modified bituminous materials can bring real benefits to highway maintenance/construction, in terms of better and longer lasting roads, and savings in total road life costing. But the choice of what materials to choose and how they perform has to be said is a bit of a minefield at present with little truly independent advice available, and this guide may help in making the necessary decisions. Certain additives or blend of additives called as bitumen modifiers can improve properties of Bitumen and bituminous mixes. Bitumen treated with these modifiers is known as modified bitumen. Polymer modified bitumen (PMB)/ crumb rubber modified bitumen (CRMB) should be used only in wearing course depending upon the requirements of extreme climatic variations. The detailed specifications for modified bitumen have been issued by IRC: SP: 531999. It must be noted that the performance of PMB and CRMB is dependent on strict control on temperature during construction.

II. POLYMER MODIFIED BITUMEN

Some bitumen may require modifiers, such as polymers, to meet low and high temperature requirements. Although modifiers may affect many properties, the majority of modifiers attempt to decrease the temperature dependency and oxidation hardening of bitumen and asphalt mixtures. Polymers used for bitumen modification is long chained hydrocarbon molecules that enhance the properties of neat bitumen. Depending on the basic polymer units (monomers) used, a wide range of properties can be achieved. It is possible to categorize polymers in a number of ways, but for engineering purposes they are conveniently described as having glassy (stiffness) or rubbery (elastomeric) properties. Often this is termed plastomeric or elastomeric. Plastomers will deform but will not return to their original dimensions when the load is released. Elastomers will deform and return to their original dimensions when the load is released, however, this is very dependent on conditions such as temperature, rate of loading and strain level. As the demands of a modern road system have, in some areas, exceeded the capacity of conventional bituminous materials, polymer additives are a means by which pavement performance may be enhanced.

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S.D.Katara, PG Student, L.D. College of Engineering, Ahmedabad

C.S.Modhiya, Associate Professor, Government Engineering of College Dahod, Dahod

N.G.Raval, Assitance professor, L.D. College of Engineering Ahmedabad, Ahmedabad.

III. CRUMB RUBBER MODIFIED BITUMEN

CRMB is a special type of bitumen whose properties have been improved by the addition of
crumb rubber & special types of additives like hydrocarbon materials, resins etc. thus altering the physical properties of bitumen making it more resistant to temperature variations, weather & high traffic loads, reduced maintenance costs and excellent driving comfort.
Types of CRMB & Recommendation for specific use:
CRMB 60: recommended for hot climate areas.
CRMB 55: recommended for moderate climate areas.
CRMB 50: recommended for cold climate areas.

IV. METHODOLOGY

For this research work aggregate, bitumen and Modify bitumen and Fly ash was used. Different properties of bitumen, Modify Bitumen and aggregate have been tested. Then prepare different mixes of bitumen, Modify Bitumen and fly ash with varying proportions by using wet and dry process. The percentage weight of fly ash and replace for percentage weight of bitumen taken for test. The feasibility of different mixes of bitumen and Modify Bitumen and fly ash with varying proportions with aggregate has been tested.

Experimental Program
Bituminous Mix was prepared using Marshall Method of bituminous mix design. The Bituminous Mix Design was prepared with conventional bitumen and Modify bitumen added with varying percentages of Fly Ash. The details of the experimental programme are as follows.

Recommended Value as per MORTH section 500 clause 509

Table 1 Detail of Aggregate Tests

Sr. No	Test	Recommended Value as per MORTH section 500 clause 509
1	Grain size analysis	Max 5% passing 0.75 mm sieve
2	Loss Anglos abrasion test	30% Max
3	Aggregate Impact value	24% Max
4	Flakiness and elongation Index (combined)	30% Max
5	Water absorption	2% Max
6	Specific Gravity	2.5-3.0
7	Stripping value	95% min

Table 2 Detail of Bitumen Tests

Sr. No	Test	Recommendation as per IS 73- 2006
1	Penetration at 25 °C, 0.1 mm, 5 sec	50 - 70
2	Softening Point, °C, min	47
3	Specific Gravity	0.99
4	Ductility, 27 °C, cm	75
5	Viscosity, 60 °C , Poise	2400
	Viscosity, 135°C , cst	350

Table 3 Detail of PMB 70 Tests

Sr. No	Test	Recommendation as per IRC SP 53- 2002
1	Penetration at 25 °C, 0.1 mm, 5 sec	50-90
2	Softening Point, °C, min	55
3	Specific Gravity	0.90
4	Ductility, 27 °C, cm	40
5	Viscosity, 150 °C , Poise	2-6

Table 4 Detail of CRMB 55 Tests

Sr. No	Test	Recommendation as per IRC SP 53- 2002
1	Penetration at 25 °C, 0.1 mm, 5 sec	<60
2	Softening Point, °C, min	55
3	Specific Gravity	0.90
4	Ductility, 27 °C, cm	-
5	Viscosity, 150 °C , Poise	-

V. RESULT AND DISCUSSION

The Bituminous Mix was prepared by Marshall Method using 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.

Table 5.Results Bituminous Mix Design using Bitumen

Sr no	Bitumen (%)	Marshal stability (Kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids %Vv	VMA	VFB %
1	5.00	994.67	4.07	2.35	3.97	15.07	73.65
2	5.50	1176.33	3.40	2.38	2.36	14.63	83.89
3	6.00	933.00	3.20	2.36	2.34	15.58	84.96

Table 6.Results Bituminous Mix Design using CRMB

Sr no	Bitumen (%)	Marshal stability (Kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids %Vv	VMA	VFB %
1	5.00	1180.67	3.90	2.48	4.90	19.80	85.60
2	5.50	1220.02	3.75	2.46	3.45	20.30	89.76
3	6.00	1118.30	3.50	2.45	2.25	20.86	90.24

Table 7.Results Bituminous Mix Design using CRMB

Sr no	Bitumen (%)	Marshal stability (Kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids %Vv	VMA	VFB %
1	5.00	1180.67	3.90	2.48	4.90	19.80	85.60
2	5.50	1220.02	3.75	2.46	3.45	20.30	89.76
3	6.00	1118.30	3.50	2.45	2.25	20.86	90.24

Table 8.Results Bituminous Mix Design using PMB

Sr no	Bitumen (%)	Marshal stability (Kg)	Flow value (mm)	Bulk Density (gm/cc)	Air voids %Vv	VMA	VFB %
1	5.00	1356.69	3.98	2.59	5.10	20.20	88.26
2	5.50	1434.15	3.85	2.54	4.25	20.35	90.24
3	6.00	1210.19	3.64	2.53	2.30	20.70	91.15

The results show that with 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% bitumen content of bitumen varying percentages of Fly Ash was added and bituminous mix was prepared.

VI. CONCLUSIONS

The study on the use of FLY ASH reveals that the Marshal Stability value, which is the strength parameter of Bituminous, has shown increasing trend and the maximum values have increased by about 25 % by addition of FLY ASH. The density of the mix has also increased in the cases of FLY ASH when compared with 60/70 grade bitumen.

This will provide more stable and durable mix for the flexible pavements. The serviceability and resistance to moisture will also be better when compared to the conventional method of construction. The values of other parameters i.e. Vv, VMA and VFB in both the cases FLY ASH have found out to be within required specifications. This study not only constructively utilizes the waste fly ash and tyres in road construction industry but it have also effectively enhanced the important parameters which will ultimately have better and long living roads This study will have a positive impact on the environment as it will reduce the volume of waste to be disposed of by incineration and land filling. It will not only add value to waste but will develop a technology, which is eco-friendly.

REFERENCES

[1] Sabina,Khan Tabrez A, Sangita, Sharma D.K., Sharma B.M, Performance Evolution. Of Waste Plastic/ Polymers Modified Bituminous Concrete Mixes, Journal of Scientific and Industrial Research Vol.68, 2009.

[2] Yadav Kajal, Sangita and Chandra A, Identification, Characterization and Quantification of Elastomeric/Plastomeric Waste for Sustainable Waste Minimization American Journal of Environmental Sciences 1 (3) pp-202-205, 2005.

[3] Aslam Shahan-ur-Rahman "Use of Waste Plastic in Construction of Flexible Pavement", New Building Materials & Construction World, 2009.

[4] Vasudevan R., Nigam S.K., Velkennedy R., Ramalinga Chandra Sekar A., Sundarakannan B. Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers, International Conference on Sustainable Solid Waste Management, 5 - 7, Chennai, India pp-105-111, 2007.

[5] S Shankar, Prasad C.S.R.K., Evaluation of Rutting Potential for Crumb Rubber Modified Bitumen in Asphaltic Mixes, Emirates Journal for Engineering Research, 14 (2), pp- 91-95, 2009.

[6] Vasudevan, R., Utilization of waste plastics for flexible pavement, Indian High Ways Indian Road Congress, Vol. 34, No.7, 2006.

[7] Justo C.E.G., Veeraragavan A "Utilization of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads", Centre for Transportation Engineering, Bangalore University, Bangalore, India, 2002.

[8] Dr. Kadiyali L.R., Dr.Lal N.B., (2006), "*Principles and Practices of Highway Engineering",* Khanna Publishers Delhi-6.

[9] Dr. Khanna S.K., Dr. Justo C.E.G., (2003), "*Highway Engineering*", *Nem Chand & Bros*, Roorkee, India.

[10] IS 2386: (Part 1-6*)* "Methods for test on aggregates".

[11] IS: 1201-20, Methods of testing tar and bituminous materials

[12] *"Use of waste material in highway construction" (1991)* school of civil engineering Indian department of transportation. Purdue University.

[13] D S V Prasad, M. Anjan Kumar, G V R Prasada Raju, V. Kondayya *"A Study on Flexible Pavement Performance with Reinforced Fly ash Sub base"* International Journal of Earth Sciences and Engineering 4ISSN 0974-5904, Volume 04, No 06 SPL, October, pp. 403-408(2011).

[14] Henning, N. E. (1974*). "Evaluation of lignite fly ash as mineral filler in asphaltic concrete."* Report No. Item (2)-73, Twin City Testing and Engineering Laboratory, St. Paul, Minn.

[15] Jianhong Dia, Zhanliang Liu, *"Influence of Fly Ash Substitution for Mineral Powder on High Temperature Stability of Bituminous Mixture"* International Conference on Future Energy, Environment, and Materials 2012.

[16] J. Mater. *"Coal Ash Utilization In Asphalt Concrete Mixtures"* Civ. Eng. 11, 295 (1999)

[17] Robin L. Schroeder "The Use of Recycled Materials in Highway Construction" Autumn 1994 Vol. 58 · No. 2

[18] 13.Rosner. J. C., Chehovits, J. G., and Morris, G. R. (1982*). "Fly ash as a mineral filler and anti strip agent for asphalt concrete."* Challenge ofchange-6th Int. Ash Utilization Symp. Proc., U.S. Dept. of Energy, Morgan town