Flexible Pavement of 80/100 Penetration Bitumin Grade using Crumb Rubber and Fly Ash

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Abstract

India is a country, which has large road network but to maintain road quality with minimum cost is a big deal. And with this one more challenge is there, how to manage solid waste? The purpose of this research is to help both the things. Plastic waste consisting of carry bags, cups, and thermocoles can be used as a coating over aggregate and this coated stone can be used for the road construction. The generation of waste plastic is increasing day by day, the major polymers namely polyethylene, polypropylene, polystyrene shows adhesion property in their molten state. Stone aggregate is coated with the molten waste plastics. The coating of plastic reduces the porosity, absorption of moisture and improves soundness. The polymer coated aggregate bitumen mix forms better material for flexible pavement construction as the mix shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastic for flexible pavement is one of the best method for easy disposal of waste plastic. Moreover the polymer coated aggregate helps to use crumb rubber modified bitumen resulting in better result.

Keywords: Flexible pavements, crumb rubber, fly ash, bitumen, Ductility, Marshal Test.

I. INTRODUCTION

Bitumen is used as binder material for construction of roads and pavements for several years. The demand of bitumen has increased because of rapid urbanization. Crumb-rubber the ideal modifier can prove to be economical as compared to conventional bitumen. The use of crumb-rubber and fly-ash in bitumen modification is helpful to get better performance. Modified binders are also considered for structural layers because of their improved elastic modulus and fatigue strength. So the modification of bitumen is logical and economical approach.

A. Solid waste

It is non liquid waste arising from domestic, trade, industrial, agricultural, mining, construction activities and from public services. Following are different Types of Solid Waste

- Municipal Solid Waste
- Industrial Waste
- Hazardous Waste
- Hospital Waste
- Construction and Demolition Waste
- Waste from Electrical and Electronic Equipment (WEEE)

B. Need of Modified Bitumen

Modified bitumen acts as multi-grade due to their low susceptibility to daily & seasonal temperature variations

- Higher resistance to deformation at elevated pavement temperature & resistance to brittle cracking at low pavement temperature.

- Better adhesion between aggregate & binder, higher fatigue life of mixes under heavy axle load & better resistance to ageing.
- Overall improved road performance in extreme climatic & heavy traffic conditions

C. General Requirements of Modifiers:

Modifiers should have following properties

- It should be compatible with bitumen.
- It should be capable of being processed by conventional mixing & laying machinery.
- It should be Produce coating viscosity at application temperature.
- It should be able to maintain premium properties during storage, application & in service.

II. OBJECTIVES

Following are the objectives of research.

- To utilize waste materials as a pavement (in surface course) ingredients.
- To check the sustainability of waste materials in asphalt mixture.
- To Optimize of pavement design with waste materials.
- To compare the cost of modified bitumen with conventional bitumen.
- To study the effect of crumb rubber powder & fly-ash on properties of 60/70 penetration grade bitumen & their indicative doses.
- To study & compare the effect of modified bitumen in the bituminous concrete mix design with conventional bitumen.

III. TEST PROCEDURE

A. Marshall test

Mould is put out on Marshall Apparatus and Marshall Stability as well as Marshall Flow is measured by proving ring and flow dial gauge respectively. The minimum value of proving ring is 1 division = 0.01 mm and flow dial gauge 1 division = 0.25 mm. the correction factor is depends on capacity of Marshall Apparatus.

After this, the other parameters like Unit Weight (gm/cc), Specific Gravity of mix (Gmm), Air Voids (%), Voids in mineral aggregates (%), Voids filled with bitumen (%), etc. are calculated by derived formulas.

IV. RESULTS

A. Bitumen test for CRMB

Table – 1
Effect of Crumb rubber percentage on Penetration, softening point and ductility

		Percentage%			
Sr. No.	*Crumb rubber %*	*0*	*5*	*10*	*15*
	80/100 Bitumen	*100*	*95*	*90*	*85*
		Test as per IRC SP:53-2002			
1	*Penetration at 25 *c*	*67*	*59*	*52*	*45*
2	*Softening point(c)*	*45*	*50*	*55*	*65*
3	*Ductility(cm)*	*75*	*40*	*22*	*20*

B. Blending of aggregates and laboratory trial mix for bituminous concrete mix design

Table – 2
Combined gradation for CRMB

Sieve size	*20mm*	*10mm*	*6mm*	*Stone dust*	*Combined gradation*	*Lower limit*	*Upper limit*
26.5	*100*	*100*	*100*	*100*	*100*	*100*	*100*
19	*67.54*	*100*	*100*	*100*	*88.31*	*79*	*100*
13.2	*29.43*	*100*	*100*	*100*	*74.59*	*59*	*79*
9.5	*10.37*	*70.39*	*100*	*100*	*64.77*	*52*	*72*
4.75	*6.87*	*35.02*	*63.75*	*100*	*49.10*	*35*	*55*

2.36	*4.40*	*20.28*	*30.74*	*100*	*36.84*	*28*	*44*
1.18	*3.20*	*12.84*	*12.73*	*84.06*	*26.43*	*20*	*34*
0.6	*2.31*	*9.69*	*5.73*	*63.25*	*18.70*	*15*	*27*
0.3	*1.68*	*7.56*	*4.35*	*38.88*	*12.00*	*10*	*20*
0.15	*1.17*	*6.30*	*3.45*	*18.17*	*6.45*	*5*	*13*
0.075	*0.87*	*2.37*	*2.08*	*5.57*	*2.51*	*2*	*8*

C. Marshall Stability test result for CRMB

Tests were performed by replacing 80/100 penetration grade bitumen by crumb rubber in proportion of 0%, 10 %, 15 % , 20 % with respect to original weight 60gm(5%)

Table – 3
Marshal Stability Test

Sr.no.	*Crumb rubber*	*Bitumen %*	*density*	*Max. Th.sp.gravity (mm)*	*Air voids %*	*VMA %*	*VFB %*	*Corrected stability (kg)*	*Flow (mm)*
1	*0*	*5*	*2.52*	*2.61*	*3.45*	*16.29*	*78.82*	*1022,50*	*3.5*
2	*10*	*4.50*	*2.556*	*2.620*	*3.925*	*16.80*	*76.65*	*1402.43*	*3.02*
3	*15*	*4.25*	*2.547*	*2.632*	*4.135*	*16.49*	*75.25*	*1615.84*	*2.8*
4	*20*	*4*	*2.534*	*2.645*	*4.230*	*16.23*	*74.89*	*1086.41*	*2.53*

V. CONCLUSION

A. Optimization of pavement design by use of waste materials

- Crumb rubber gives the satisfactory results by using it in 15% of proportion to replace the bitumen for various tests of bitumen & bitumen mix.
- Fly ash gives the satisfactory results by using it in 10% of proportion to replace the bitumen for various tests of bitumen & bitumen mix.

B. Sustainability of waste materials in asphalt mixture

- The Marshall Stability test results with the use of crumb rubber & fly-ash Crumb rubber gives the Marshall Stability value of 1615.84 kg by using 15% of crumb rubber powder with bitumen mix, which is 1.6 times greater than the Marshall Stability value of conventional bitumen mix. It also increases the softening point of bitumen & decreases penetration & ductility value which improves the quality if modified bitumen, so it is better to use it in 60/70 penetration grade bitumen than fly-ash.
- Fly ash gives the Marshall Stability value of 1542.52 kg by using 10% of crumb rubber powder with bitumen mix, which is 1.5 times greater than the Marshall Stability value of conventional bitumen mix. It decreases ductility value of bitumen & increase in softening value to some extent. Penetration value remain same as the conventional bitumen.

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