

Use of Waste Plastic in Bituminous Concrete

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Abstract: Bituminous concrete (BC) is most commonly used all over the world in construction projects like road surfacing (flexible pavements), parking lots, airports etc. BC mainly consists of asphalt or bitumen (used as a binder) and mineral aggregates which are mixed together in desired proportions and laid down in layers and then compacted. Now a days, due to increment in traffic and the significant variation in daily or seasonal temperature, it has put us in demanding situation to think of some alternative for improving the pavement characteristics and quality by applying some necessary modification which shall satisfy both the strength as well as economical aspect. Usage of waste plastic can be a promising alternative and it will also solve plastic disposal problem which is favorable to the environment. Plastic wastes may be in terms of bottles, carry bags and other utilized plastic which can be used in shredded form. This paper presents a research conducted to study the behavior of bituminous concrete mix modified with waste plastic. The various properties of bituminous concrete with or without plastic were checked. As per IRC 111-2009, the quantity of the bitumen in BC was from 5.2% to 6.8%. The waste plastic is added in various percentages (5% to 9%) in all samples to replace the bitumen with these percentages in BC. Then the Marshall Test for flow and stability with all void analysis are done on all samples.

Keywords: Bituminous Concrete, Waste Plastic, Marshall Test, Flow, Stability.

1. Introduction

Bituminous mixes are most widely used all over the world in flexible construction. As we know that plastic cannot be decomposed. It is pavements durable and non-biodegradable, the chemical bonds make plastic durable and resistant to a normal natural process of degradation. Plastics are compounds of carbon and hydrogen known as hydrocarbons. Some properties of plastic include their light weight, high resistance to various chemicals, Indian plastic industry made a beginning in 1957 with a production of polystyrene by commencing production of Polystyrene. The arrangement of manufacture of Indian polymer is summarized as under 1957-polystyrene, 1959-LDPE, 1961-PVC, 1968-HDPE and 1978-Polypropylene. Today in India there are about 22000 plastic processing units and 150 plastic processing machinery manufacturers. The per capita consumption of plastic products in India is growing by 8% GDP growth. Also, considering the environmental approach, the use of plastic is increasing in incredible ways. As we know that plastic cannot be decomposed and this leads to many environmental issues. Therefore, it must be utilized by recycling all these wastes for the purpose of laying roads. These wastes consist of plastic bottles; carry bags, cups and other

utilized plastic. Bituminous binders are widely used by paving industry. A pavement has different layers. The main constituents of bituminous concrete (BC) are coarse aggregate, fine aggregate and bitumen. Generally, there are two types of pavements based on design considerations, i.e. Flexible and rigid pavements.

2. Objectives

- 1) To determine the optimum bitumen content.
- 2) To determine the optimum plastic content.
- 3) To determine the effects on mechanical properties of a mix.
- 4) To determine the physical properties of aggregate, bitumen, filler.
- 5) To evaluate and compare results of modified and conventional mixes.
- 6) Stability comparison of convectional or plane modified mix.

3. Methodology

To adopt the methodology for any work is the most important and difficult task. The methodology is a blue print on which whole work is carried out. The methodology adopted in this work is listed below.

- a) To conduct the standard test on aggregates.
- b) To conduct the standard test for the properties of bitumen.
- c) To determine the optimum binder content for Mix VG30 by Marshall Stability method.
- d) Mixing of shredded plastic by various percentages from 4% to 8% by weight of bitumen.
- e) To check the properties of waste plastic in bituminous concrete.
- f) To find outflow and stability by conducting Marshall test on sample.

4. Experimental work

Table 1

Property	Results	Test Method	MORTH Specification [IS 2386]	Property	Results	Test method	IS Specification
Aggregate Crushing value (%)	22.30%	IS 2386 (Part IV)		Penetration Test at 25° (mm)	64.5	IS 1203-1978	50-70
Aggregate Impact value (%)	14.76%	IS 2386 (Part IV)	Max: 24%	Softening Point Test (°C)	48.2	IS 1203-1978	Min: 47
Aggregate Abrasion value (%)	22.7%	IS 2386 (Part IV)	Max: 30%	Ductility Test (mm)	85	IS 1203-1978	Min: 40
Flakiness index (%)	18.56%	IS 2386 (Part II)	Max: 35%	Specific Gravity Test (mm)	1.02	IS 1203-1978	Min: 0.99
Elongation index (%)	21.52%						
Water Absorption test	1.02%		Max: 2%				

The experimental work does not involve Marshall Test only but other tests on aggregate and bitumen should also be performed. The main reason of performing tests on bitumen and

aggregate is just to check whether their test values lies within the limit as prescribed in codes IRC III-2009.

1) Marshall Test

- For preparing bituminous mix required quantities of coarse aggregate, fine aggregate and filler were taken in a pan. The pan was kept in the oven for preheating at a temperature of 175°C for 2 hours. This is because the aggregate and bitumen are to be mixed in heated state.
- Side by side the bitumen was also heated up to its melting point before mixing. The compaction mould assembly is cleaned and kept in the oven for preheating to a temperature of 100 to 145°C.
- The required amount of shredded plastic was weighed and kept in a pan separately.
- The plastic was added to the aggregate and was mixed thoroughly for 2 minutes.
- Now the bitumen in required percentage is added to the mix and the whole mix was stirred for 10 to 20 minutes until it forms uniform colour throughout the mix.
- After mixing whole mix is transferred to casting mould.
- The mould is placed in the Marshall Compaction pedestal. The mix is compacted with 75 no. of blows of the hammer and the sample is inverted and compacted in the other face with same no. of blows.
- After compaction, the sample with mould is kept for few hours to cool. The sample is extracted out from the mould and kept at room temperature for 24 hours.
- Before testing, the sample is kept in the water bath having a temperature of 60°C for 20-30 minutes. The mass of sample in air and submerged weight is used to measure the density of the specimen, so as to allow, calculation of the void properties.

2) Marshall Test Results

Table 2
Marshall Values without plastic content

Bitumen Content	Marshall Stability value (kg)	Marshall Flow value (mm)	Unit weight	%age voids in total mix	VFB
5%	1329.6	3.35	2.30	5.26	78.18
5.8	1629.3	2.7	2.44	4.5	83.29
6.3%	1821.0	2.94	2.51	3.91	89.42
6.6%	1518.0	3.42	2.47	3.42	92.1
6.9%	1473.5	3.61	2.4	3.03	96.08

Plotting of curves for Marshall Values without plastic

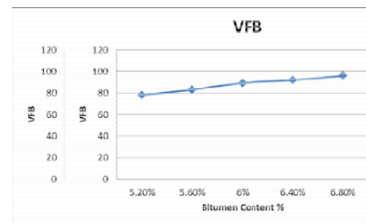
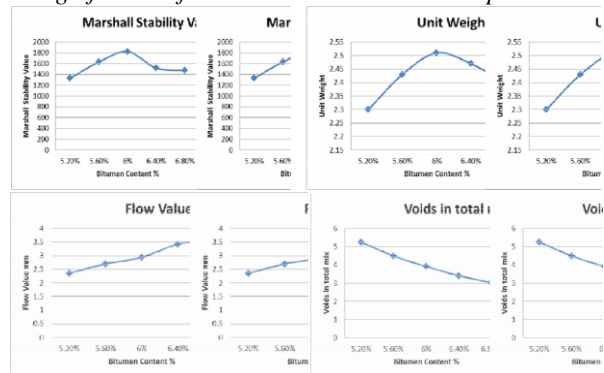


Table 3

Marshall Values with plastic Data for plotting curves of stability and flow for different %age of plastic

Bitumen content (%)	Percentage of plastic	Mean Marshall stability (kg)	Mean Flow (mm)
	5	1575	2.11
	6	1654	2.2
5.2	7	1742	2.34
	8	1735	2.63
	9	1697	2.75
	5	1758	2.50
	6	1858	2.62
5.6	7	1969	2.8
	8	1945	2.9
	9	1886	3.01
	5	1948	3.01
	6	1978	3.16
6	7	2127	3.23
	8	2085	3.32
	9	1957	3.45
	5	1697	3.16
	6	1787	3.16
6.4%	7	1858	3.53
	8	1805	3.72
	9	1777	3.81
	5	1667	3.42
	6	1687	3.60
6.8%	7	1785	3.71
	8	1727	3.85
	9	1687	4

5. Conclusion

- From the research work it was found that Marshall Characteristics improves after adding waste plastic in mix.
- Plastic increases the melting point of bitumen.
- Optimum bitumen content of BC comes out at 6% after adding waste plastic to the mix the optimum plastic content comes out at 7%, after that the value of stability decreases.
- From the research it is observed that Marshall Stability value increases after addition of plastic content up to 7% by weight of bitumen.

References

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