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Comparative study between bitumen roads and plastic bitumen Roads

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ABSTRACT: In this paper we are going to study about the comparison of bitumen roads with plastic bitumen roads. As the population and development activities is growing rapidly the quantum of plastic waste in municipal solid waste is increasing, which leading to widespread littering on the landscape. Once the used plastic material is generally thrown out and they do not undergo bio decomposition. Therefore the waste is either landfilled or incinerated. Both the actions are not eco-friendly as it pollutes the land and the air. There are many ways to stop the plastic pollution. The lots of small individual actions can have a big impact on the planet. Currently, majority of Indian roads are paved with asphalt(Hot &Warm) consists of aggregate and bitumen mixed together at specific temperature, developed techniques to use plastic waste for construction purpose of roads and flexible pavements has reviewed. This waste modified bitumen mix show better binding property, stability, density and more resistant to water.

INTRODUCTION: Any of a group of synthetic or natural organic materials that may be shaped when soft and then hardened, including many types of resins, proteins: used in place of other materials is termed as plastic. The waste that is produced from such materials is known to be plastic waste. Plastic wastes are durable and non-biodegradable. The improper disposal of plastic may cause many health issues for both animals and humans. Hence, it is needed that plastic products must be recycled and not end in landfills. Hence, one is the way of disposing some types of plastic waste into roads as binding materials in replacing of bitumen. Proper addition of such waste in bitumen improves quality, life and minimizes construction cost of road.

SCOPE: To reduce the plastic waste in the environment and increase the sustainability of roads

OBJECTIVES:

- To compare the sustainability of bitumen roads with plastic roads.
- To compare the cost of roads
- To compare the working efficiency of bitumen & plastic roads.

METHODOLOGY: The debate on the use and abuse of plastics on environmental protection can go on, without yielding results until practical steps are initiated at the basic level by everyone who is in a position to do something about it. So different test were conducted on aggregates with plastic and bitumen. The tests conducted for the normal aggregates, plastic coated aggregates & bitumen coated aggregates are given in the below description. There are two important process used for bituminous flexible pavement, they are

[i] Wet process

[ii] Dry process

WET PROCESS:

SAMPLE PREPARATION:

Segregation, cleaning and shredding of plastic is done before preparation of sample's, when the bitumen is at 110-160^{o}c temperature then the shredded plastic is added to the bitumen

PENETRATION TEST:

Bitumen and plastic is Soften to a pouring consistency between 75-100^{o} c above the approximate temperature at which bitumen softens. Then sample material is then poured into the container to a depth at least 15mm more than the expected penetration. The Penetration of all samples are obtained, by taking at least three measurements on each sample, at a distance of at least 100mm.

DUCTILITY TEST:

The mould assembly is placed in water bath for 85-90 minutes. Then specimen is clipped to the ductility machine. Record the distance at which the bitumen thread of each specimen breaks is recorded as the ductility value.

SOFETNENING POINT:

Samples are immersed in distilled water for 15 min. Then place ring in softening apparatus by placing boll on top of the sample on the ring. The temperature then raised at a uniform rate of 5^{o} c per minute with a controlled heating unit, until the bitumen softens and the balls on top of them sink through. This process is repeated at least two observations.

FLASH AND FIRE POINT:

FLASH POINT:

Flash point is taken as that temperature when a flash appears at a point on the surface of the material in the cup.

FIRE POINT:

After flash point, heating should be continued at such a rate that increased in temperature recorded by the thermometer in neither, less than 5^{o} c not more than 6^{o} c per minute. The fire point should be taken as tampered on the thermometer at which the application of test flame causes the material to ignite and burn for at least 5 sec

DRY PROCESS:

SAMPLE PREPARATION:

Aggregates of different sizes such as 10mm, 12.5mm, are taken which are needed for conducting attrition, abrasion, crushing, impact, specific gravity and water absorption tests. Collected aggregates are cleaned and dried. Plastic will start melting when it is heat up to 110-160^{o} c then melted plastic is coated on the aggregates and then dried at room temperature.

LOS ANGLES ABRASSION TEST:

Size of aggregates and number of sphere's used for loss angles abrasion test depends upon the grade we considered. Sphere's of diameter 4.8cm and weight 390 to 445gm is used. Test is carried out for 500 Revolutions. After 500 Revolutions, crushed aggregates are taken out and sieve the aggregates through 1.7mm sieve. We have to calculate the weight of crushed aggregates passing through 1.7mm sieve.

DEVAL'S ATTRITION TEST:

For Deval's attrition test we have to consider 2.5KG of aggregates which is passing through 20mm sieve & retain on 12.5mm size sieve. No of revolutions for Deval's attrition test are 10,000. After completion of revolutions the crushed aggregates is taken out and sieve through the 1.7mm size sieve. We have to calculate the weight of crushed aggregates passing through 1.7mm size sieve.

CRUSHING VALUE TEST:

Aggregates are placed in a crushing cylinder of 111.5cm diameter and 18cm height. 40 tons of load, is applied for the crushing test. After applying 40 tons of load, crushed aggregates are taken out & sieve through 2.36mm sieve. We have to calculate the weight of crushed aggregates passing through 2.36mm size sieve.

AGGREGATE IMPACT VALUE TEST:

Aggregates are placed in impact mould of 9.5cm dia & 5cm height in 3 layers by tampering 25 times for each layer by using tampering rod. Impact test is conducted for the 15 blows.

SPECIFIC GRAVITY:

A clean, dry pycnometer is taken & its empty weight is determined. About 1000gm of clean sample is taken into the pycnometer & it is weighed. Then fill pycnometer with water & it is weighed. Now the pycnometer is completely filled up with water & it is weighed

WATER ABSORPTION:

Aggregate passing through 125mm sieve and retained on 10mm sieve is selected for water absorption test.

RESULTS: The results were compared and shown in the below table for the following process like dry & wet respectively:

DRY PROCESS:

Type of test	General aggregate	Plastic coated aggregates	Bitumen coated aggregates
Abrasion test	33.6%	27.2%	15%
Attrition test	28%	8%	6%

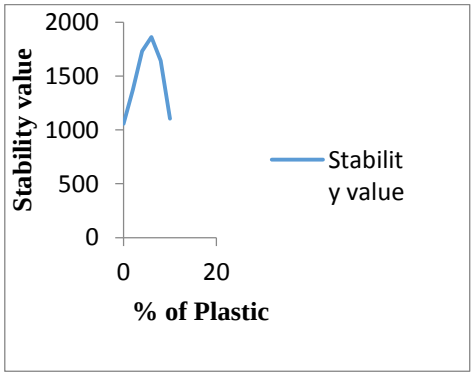
Crushing test	26.19%	20.63%	16%
Impact test	22.104%	10.584%	5.6%
Specific gravity test	2.77	2.27	2
Waterabsorption test	1.8%	1.5%	0.8%

Wet process:

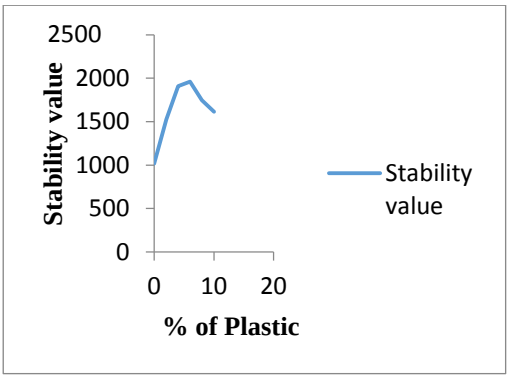
Percentage of plastic	*Ductility test*	*Penetration test*	*Softening point*	*Flash point*	*Fire point*
0	*103.5*	*68*	*50*	*290*	*340*
2	*62.8*	*56*	*51*	*294*	*340*
4	*39.6*	*45*	*56*	*313*	*346*
6	*31.6*	*31*	*63*	*329*	*350*
8	*20.5*	*20*	*69*	*327*	*342*
10	*9.1*	*18*	*70*	*295*	*310*

Marshall Stability: The Marshall Stability values for the specimens are given below

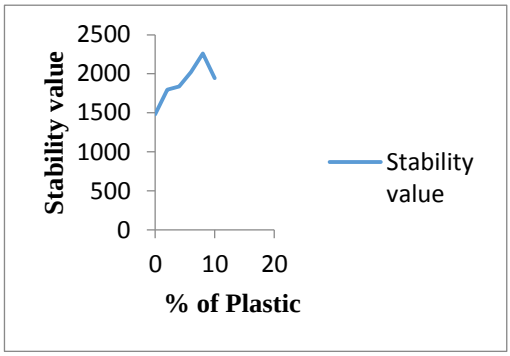
Content (%)	%of plastic content					
	0	**2**	**4**	**6**	**8**	**10**
4	1056	1371	1732	1862	1641	1104
4.5	1018	1524	1910	1961	1746	1614
5	1479	1797	1839	2024	2260	1944
5.5	1970	2050	2210	2350	2401	2325
6	1820	1535	1910	2087	1908	2186



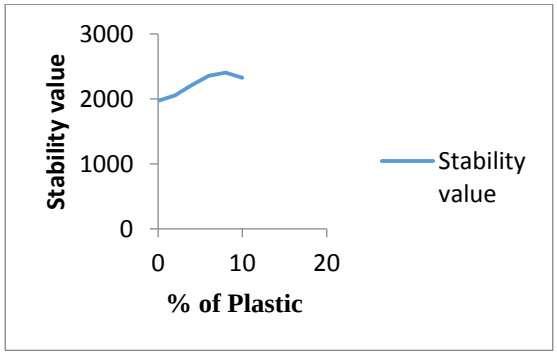
For binder content 4%



For binder content 4.5%



For binder content 5%



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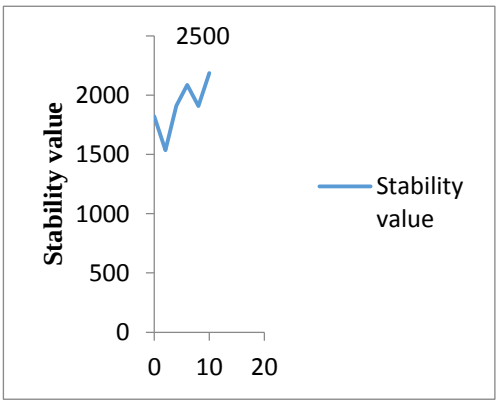
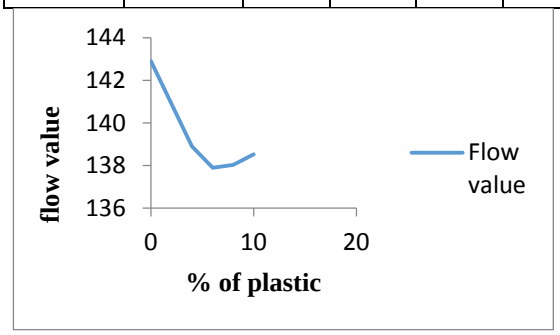


For binder content 6%

Flow values:

The flow values for Marshall Mix design are represented below:

Binder Content (%)	% of plastic					
	0	2	4	6	8	10
4	142.90	140.9	138.9	137.0	138.2	138.3
4.5	143.52	143.0	140.2	138.7	139.5	139.5
5	144.14	144.64	142.52	141.2	140.9	140.4
5.5	146.01	145.2	143.9	142.4	141.9	140.4
6	147.26	147.2	145.3	143.6	142.2	141.2



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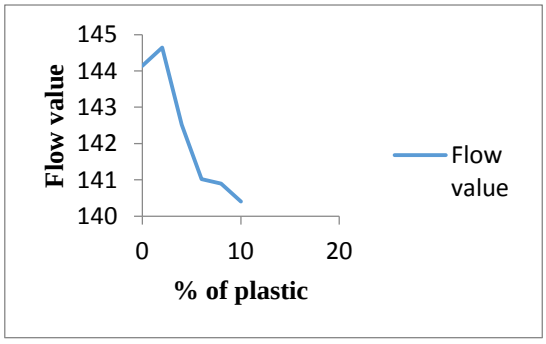

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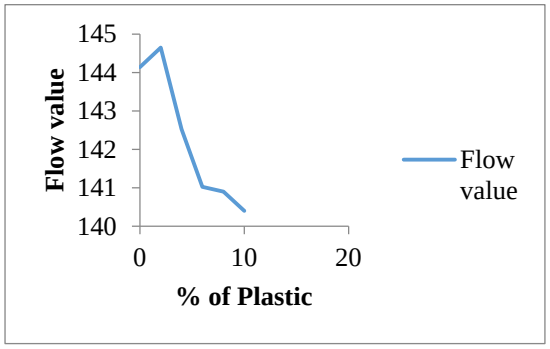

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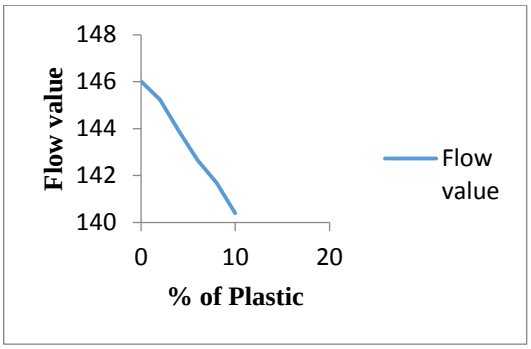

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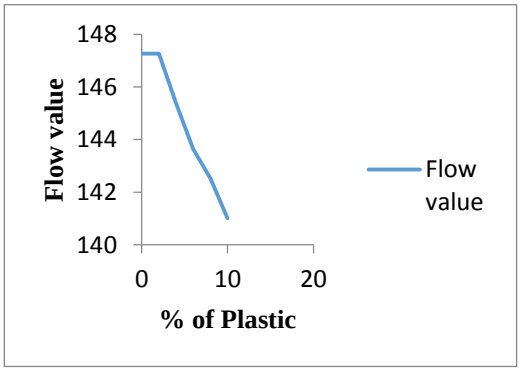

For binder content 6%

CONCLUSION:

- In general excess binder content causes bleeding problems especially at high temperature, whereas any deficient amount of binder may cause cracking, loss of aggregates, pot holes problems etc. In India due to manual mixing, it is very difficult to control the temperature and optimum amount of bitumen in the mix. In this regard polymer (waste plastic) modified binder could be a better solution due to its low ductility, high softening point and enhanced elastic properties.
- As the modified binder increases strength of compacted mix by a big margin, cost saving could be achieved in pavement construction and maintenance.
- Since waste plastic modified bituminous binder has the potential to make pavement long lasting, to reduce construction cost and maintenance frequency, it holds a huge potential and a great prospect in prevailing weather conditions and road construction practices in India.
- Drainage problem is a big issue in urban area and waste plastic is mainly responsible for water lobbing. So use of waste plastic with

bitumen in road construction may be a better solution.

- The unit cost of waste plastic is about 30% less than that of pure bitumen. Hence the use of waste plastic with bitumen may be economically viable for road construction and maintenance work.

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