UTILIZATION OF WASTE MATERIALS IN PAVEMENT CONSTRUCTION

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Abstract - ***We would like to brief the project in which we are working. Nowadays, quantity of plastic waste, municipal solid waste, unuseful tires are increasing due to increase in population, urbanization, development activities and change in lifestyle. This waste is disposed by land filling and incineration, which are hazardous and not ecofriendly.***

On the other hand, plastic bottles, waste polymers, cups, waste tires can be reuse by powdering or blending it with crushers and can be coated over aggregate or mixed with bitumen by heating process. Polymer and crumb rubber can be use as a binder with respect to aggregate and bitumen in construction of flexible pavement.

The various tests can be conduct during this study on aggregate i.e. crushing value, impact value, abrasion value, specific gravity and also on bitumen i.e. penetration value, ductility, softening point, etc. obtained results can be give rise to better quality roads and utilization of waste materials in pavement construction.

Key Words: *pavement , polymer, bitumen*

1.INTRODUCTION

Due to day by day increase in population and urbanization people are using polymers, plastics, automobiles, etc. liberally. Civilization also produces waste products. Disposal issue of the waste products is a challenge and traditionally used methods of disposal (land filling, incineration) are hazardous and non-ecofriendly. Some of these waste materials are not biodegradable and often leads to waste disposal crisis and environmental pollution. The present article seeks the possibilities of whether some of these waste products can be utilized as highway construction materials. Traditionally soil, stone aggregates, sand, bitumen, cement etc. are used for road construction. Natural materials being exhaustible in nature, its quantity is declining gradually. Also, cost of extracting good quality of natural material is increasing. Polymer and crumb rubber can be use as a binder with respect to aggregate and bitumen in construction of flexible pavement. The various tests can be conduct during this study on aggregate i.e. crushing value, impact value, abrasion value, specific gravity and also on bitumen i.e. penetration value, ductility, softening point, etc. obtained results can be give rise to better quality roads and utilization of waste materials in pavement construction.

2. POLYMER MODIFIED BITUMEN

The methodology describes the procedure to be adopted for blending operation of Polymer Modifier with the straight run refinery bitumen for manufacturing Polymer Modifier Bitumen (PMB).

2.1 Blending Operation

i. The base bitumen (VG10 or 30 grade) shall be delivered to the blending tank at the temperature (150C-160C) either from bitumen storage tank or directly unloaded from the truck load.

ii. The quality of bitumen delivered at the blending tank shall be checked by using dip stick for finding out the quantity from pre-calibrated chart done at various level of bitumen at the blending tank.

iii. Optimum quantity (1.5% by wt. Of bitumen) of polymer required to be mixed with the base bitumen at the blending tank shall be pre-weighted and kept over the blending platform.

iv. Bitumen polymer blending tank shall be equipped with the fuel oil burner heating system capable of heating the bitumen up to 210C. Addition of polymer shall be started around temp. Of 200C-210C withdrawal of heating shall be done during the addition of polymer. The bitumen and polymer shall be stirred and mixed together in the blending unit at the said temp. And then reacted for a minimum of 2 hours from the time the polymer is added to the bitumen.

v. Catalyst @0.2 % by wt. Of bitumen shall be also added after 2 hours of blending of bitumen polymer mix for a period of 90 minutes. The temperature of the bitumen-polymer shall be maintained between 190C-200C till the end of blending process. As soon as the blending is over ,sample shall be drawn to check for each batch for

softening point, penetration & elastic recovery to meet the specification of IRC:SP:53-2002 before delivering it to the PMB storage tank.

3. LABORATORY TESTING AND RESULTS

3.1 Softening Point Test

Bitumen does not suddenly change from solid to liquid state, But as the temperature increases, it gradually becomes softer until it flows readily. All semi-solid state bitumen grades need sufficient fluidity before they are used for application with the aggregate mix. For this purpose bitumen is sometimes cutback with a solvent like kerosene. The common procedure however is to liquefy the bitumen by heating. The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test. For bitumen, it is usually determined by Ring & Ball test.

Table-1 : Softening Point Test results

Test property	**Ball no.**	
	1	2
Temp. @ which sample touches bottom plate (C)	69.3	69.5

3.2 Penetration Test

In this test we examine consistency of a sample of bitumen by determining the distance in terms of mm that a standard needle vertically penetrates the bitumen specimen under known condition of loading, time & temperature. This is most widely used method of measuring hardness of bituminous material.

Table-2 : Penetration Test results

Sr. No.	**Dial Reading (mm)**		**Penetration (mm)**	**Avg. Penetration (mm)**
	Initial	Final		
1	145	179	34	35.66
2	149	186	37	
3	151	187	36	

3.3 Elastic Recovery Test

The elastic recovery of modified bitumen is evaluated by comparing recovery of thread after conditioning specimen for 1 hour at specified temperature and the specimen is elongated up to 10 cm deformation in a ductility machine. This is mainly intended to assess degree of bitumen modification and quality of modified bitumen.

Table 3 : Elastic Recovery Test results

Sr. No.	Test Property	Test No.		Avg.
		1	2	
1	Elongation of test specimen to a specified deformation(cm)	10	10	
2	Breakage of test specimen after conditioning of 1 hr @ 15 C & rejoining the fixed end of test specimen – X cm	2.6	2.4	
3	% of Elastic Recovery =[(L1-X)/L1]*100	74	76	75.00%

3.4 Marshall Stability & Flow Value Test:

Marshall Stability Value:

It is defined as the maximum load at which the specimen fails under the application of the vertical load. It is the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute (2 inches/minute). Generally, the load was increased until it reached the maximum & then when the load just began to reduce, the loading was stopped and the maximum load was recorded by the proving ring.

Marshall Flow Value:

It is defined as the deformation undergone by the specimen at the maximum load where the failure occurs. During the loading, an attached dial gauge measures the specimen's plastic flow as a result of the loading. The flow value was recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum load was recorded.

Table 4 : Marshall Stability & Flow Value Test results

% Bitumen	Sample Wt. gm	Marshall stability kg	Flow mm
4.66	1245	11.49	3.7
5.10	1250	12	3.6
5,20	1240	11.8	3.8

3.4.1Finding Optimum Polymer content:

The value of polymer content at which the sample has maximum Marshall Stability value and minimum Marshall Flow value is called Optimum polymer content.

From the figure a & b, we get the Optimum Polymer content as 1.5%.

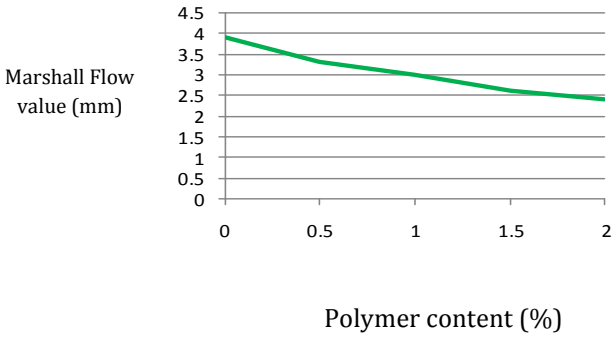

Chart 1:- Marshall Flow Value v/s Polymer content

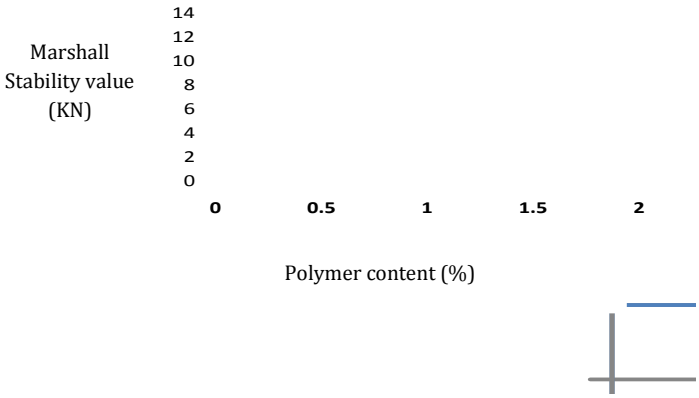

Chart 2: Marshall Stability Value v/s Polymer content

It is observed that Marshall Stability value increases with polymer content up to 1.5% and there after decreases. We observe that the Marshall Flow value decreases upon addition of polymer i.e., the resistance to deformations under heavy wheel loads increases.

4. COMPARISON

After performing the various tests in Laboratory, the various values for the various tests are obtained for Polymer modified bitumen (PMB), Which are as show in table.

The same tests were performed for Bitumen (VG-30) and the obtained values for various tests are also mention in below table.

Table 5: Comparison table (VG-30 v/s PMB)

Tests	VG-30	PMB
Softening Point Test(C)	48.7	69.4
Penetration Test(mm)	68	35.66
Ductility Test (cm)	87	75
Marshall Stability Test (KN)	9	12

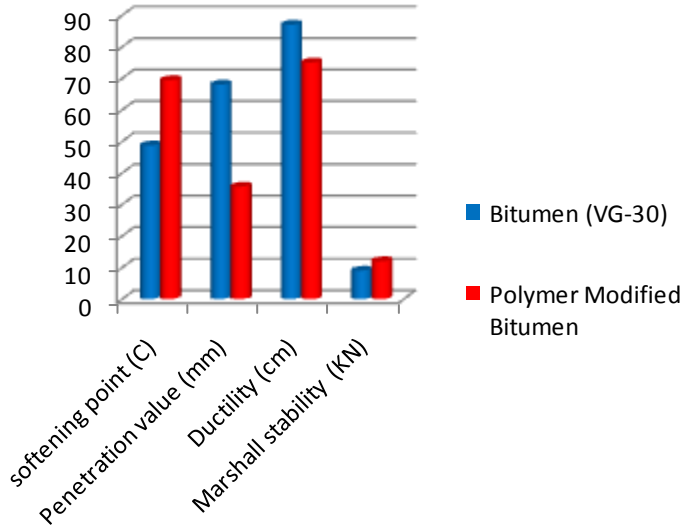

chart 3:-Comparison of Physical properties between Bitumen (VG-30) & PMB

By conducting Softening point test we obtained result that the softening point of the PMB is higher than the VG-30. So it is advisable to use PMB in pavement construction to minimize problems like, Rutting and Skidding of vehicles during hot climate conditions.

From the penetration test we found that the hardness of the Polymer Modified Bitumen is higher, compare to VG-30. So the problems like pot holes, generation of cracks in pavement can be eliminate, which also reduce the maintenance cost of the road.

From Marshall Stability test we obtain that the pavement which is constructed by using the Polymer Modified Bitumen has more stability compare to VG-30 that helps against problems like distortion, displacement, rutting, etc.

5. CONCLUSIONS

- From the study of the behavior of Polymer Modified Bitumen it was found that the modified mix possesses improved various characteristics of pavement. Considering these factors we can obtain more stable and durable mix for the pavement by Polymer Modification. In India temperatures frequently rises past 50C, leaving most of the road with heavy distress, which adversely affects the life of the pavement. To overcome this problem it is beneficial to use the Polymer Modified Bitumen in pavement construction. This also reduce the amount of plastic waste which is hazardous to the environment as well as human being.
- By utilizing waste polymers in pavement, it improves the pavement performance and reduces environmental pollution, and reduces the need to utilize virgin polymers in pavement, thus leading to cost savings. The frequency of voids is reduced due to increased bonding and area of contact between polymers and bitumen. Hence, the roads can withstand heavy traffic, thereby making them more durable. This ultimately helps in decreasing the moisture absorption and oxidation of bitumen by entrapped air.
- Regarding to Polymer Modified Bitumen we have conducted various tests i.e., Softening point test, Penetration test, Marshall stability test, Elastic recovery test, Separation test and by comparing PMB with VG-30 we conclude that our material is of improved quality.

- Polymer Modified Bitumen has the ability to offer improved performance over VG-30. The advantages of Polymer Modified Bitumen can include one or more of the following for road works:
  - ✓ Reduce susceptibility to temperature variations.
  - ✓ Higher resistance to deformation at high pavement temperature.
  - ✓ Delay of cracking and reflective cracking.
  - ✓ Better age resistance properties.
  - ✓ Better adhesion between aggregates and binder.
  - ✓ Higher fatigue life of mixes.
  - ✓ Improved consistency.
  - ✓ Improved flexibility and toughness.
  - ✓ Improved rutting resistance.
  - ✓ Increase the strength and performance of the road.
  - ✓ Generate jobs for rag pickers.
  - ✓ Develop a technology, which is eco-friendly.
  - ✓ Provides an alternative for polymer waste disposal.
  - ✓ Problems like thermal cracking and permanent deformation are reduced in hot temperature region.
  - ✓ Overall performance of pavement is improved.

- However, Polymer Modified Bitumen is little bit costlier than conventionally used binder material but in long run it may be economical due to less maintenance requirement and improved superior properties.
- So, it is recommended that more research regarding the topic should be done and more trial section should be laid and their performance should be studied.

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