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## Experimental study on characteristics of bitumen mixed with plastic waste and natural fiber

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### ABSTRACT

*Disposal of waste materials together with waste plastic baggage has become a significant drawback and waste plastics area unit burnt for apparent disposal that causes environmental pollution In the present experimental investigation, attempts are made to study on the various properties like penetration test, ductility test, softening point test, specific gravity test, viscosity test, flash and fire point test, Experiments were conducted for both Ordinary bitumen and waste polythene bitumen with different percentages of waste polythene. It was observed that variation of stability with waste plastic more stability shows from 5% bitumen sample with 8%plastic added value 1972 (Kg). Show that increasing bitumen percentage and plastic with decreasing the stability of the bitumen mix. The lower value of stability is 1508kg obtained from 6.5% bitumen with 12% plastic. Also, clear that flow value of bitumen with the addition of plastic is the higher value obtained from mix M4 at 5% of bitumen, and 8% plastic. It is clear that increasing percentage of bitumen and with increasing of waste plastic than decreasing flow value of bitumen compare with mix 8% plastic and 5% bitumen respectively.*

**Keywords**—Waste plastic, Natural fiber, Penetration test, Marshall Stability, Ductility test, Flash and fire point test, Viscosity test

### 1. INTRODUCTION

The major threat to the environment is the disposal of waste plastic. In a highway, the potholes and corrugation are the major problem. Plastic pavement will be a better solution to the above-stated problems. A material that contains one or more organic polymer of large molecular weight, solid in its finished state, can be shaped by its flow is called “plastic”. The durability of plastic is high and it degrades very slowly. And also, plastic has high resistant to degradation. Plastic can be divided into two major categories- thermoses & thermoplastics Thermoses have high durability and strength because it solidifies irreversibly when heated, henceforth can be used primarily in construction application. Plastic is a non-degradable waste, causes the greenhouse effect and global warming. The various experiments have been carried out whether the waste plastic can be reused productively. The various literature indicated that the waste plastic when added to hot aggregates, will form a fine coat of plastic over the aggregate and such aggregates when mixed with a binder is found to have higher strength, higher resistance and better performance over a period of time. Along with bitumen, use waste plastic increases its life and smoothness. It is economical and eco-friendly.

### 2. MATERIALS USED

#### 2.1 Cement

Bitumen is a material which is a byproduct of the petroleum refining process. It is highly viscous at a temperature above 100 degrees Celsius and is solid at room temperature. In this study bitumen used is 80/100 grade. Basic physical parameters of bitumen are found using various tests as tabulated in the table.

#### 2.2 Aggregate

An aggregate which has good and sufficient strength, hardness, toughness, and soundness have to be chosen. Crushed aggregates produce higher stability. Basic physical parameters of aggregates are found using various tests as tabulated in tab the specific gravity 2.71 and water absorption 0.40 percentages. Aggregate impact value is 23.85 respectively.

#### 2.3 Natural fiber

Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. It is obtained from the sisal plant. The specific gravity of sisal fiber is 0.71 and diameter of sisal fiber 0.25mm and 50mm length used in the research work.



**Fig. 1: Sisal fiber**

**2.4 Waste plastic**

Polyethylene Terephthalate (PET) plastic from the family of polyesters, is nowadays being used mainly in the food industry for packaging soft drinks, mineral water, milk, oil, bakery products, frozen foods, salad dressings, cosmetics, cleaners, and many other products. use of plastic in the research of Passing 4.75 mm sieve retained on 2.36 mm sieve specific gravity 1.05 or melting point 250-265 C° waste plastic collected from old city Bhopal.

**3. EXPERIMENTAL PROGRAM**

The objectives of this study were to examine the strength of various properties of waste plastic bitumen mix at different percentages of waste plastic. Properties which were examined are:

- (a) Penetration test
- (b) Ductility test
- (c) Softening point test
- (d) Specific gravity test
- (e) Viscosity test
- (f) Flash and Fire point test

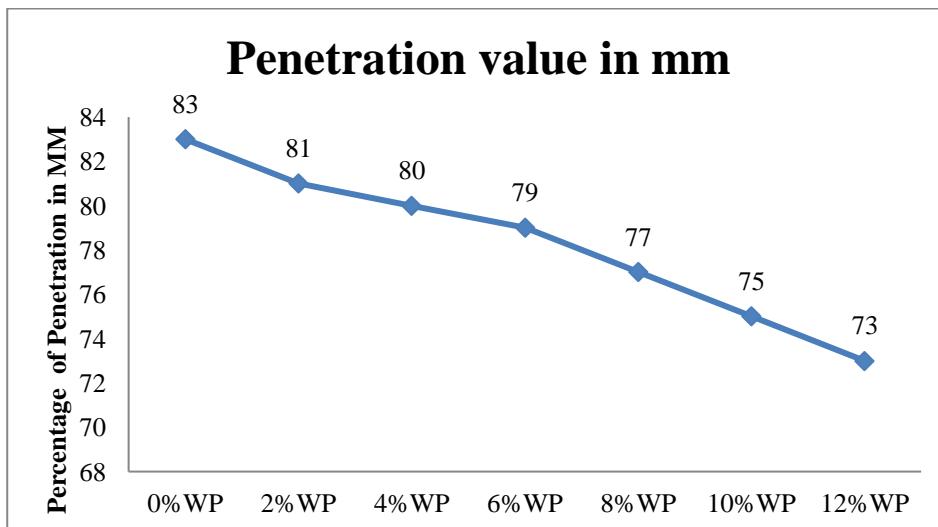
**4. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS**

The objectives of this study were to examine the strength of various properties of waste plastic bitumen mix at different percentages of waste plastic. Properties which were examined are:

**4.1 Penetration Test of mixes results**

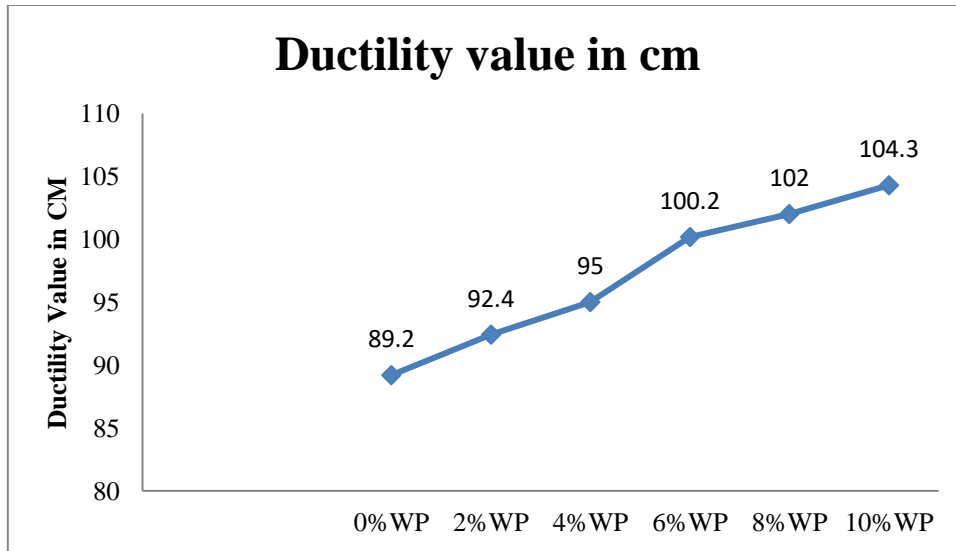
**Table 1: Penetration value results in mm**

Mix no.	Description of sample % of PET	Penetration value in mm (80/100)	SF%
M1	0% WP	83	0.2%
M2	2% WP	81	0.2%
M3	4% WP	80	0.2%
M4	6% WP	79	0.2%
M5	8% WP	77	0.2%
M6	10% WP	75	0.2%
M7	12% WP	73	0.2%

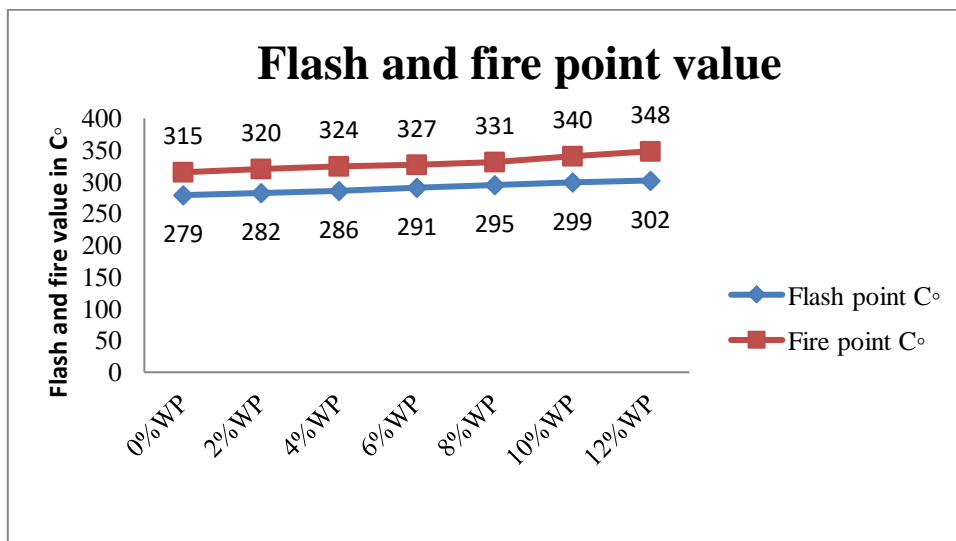


**Fig. 1: Variation of penetration value with waste plastic**

Table 1 shows that the addition of waste plastic by weight of bitumen shows decreasing in penetration value of the bitumen mixes compared with control mix of bitumen. Mix M1 penetration value 81mm with compare to mix M5 penetration value is 77 which are decreasing by 7.22%. It can also be observed from Figure 1 that increasing the percentage of waste plastic with decreasing penetration value of all mixed. Further uses of waste plastic in bitumen up to 8% value is under criteria of IS code than increasing of plastic percentage with less penetration value obtained compare to normal bitumen.

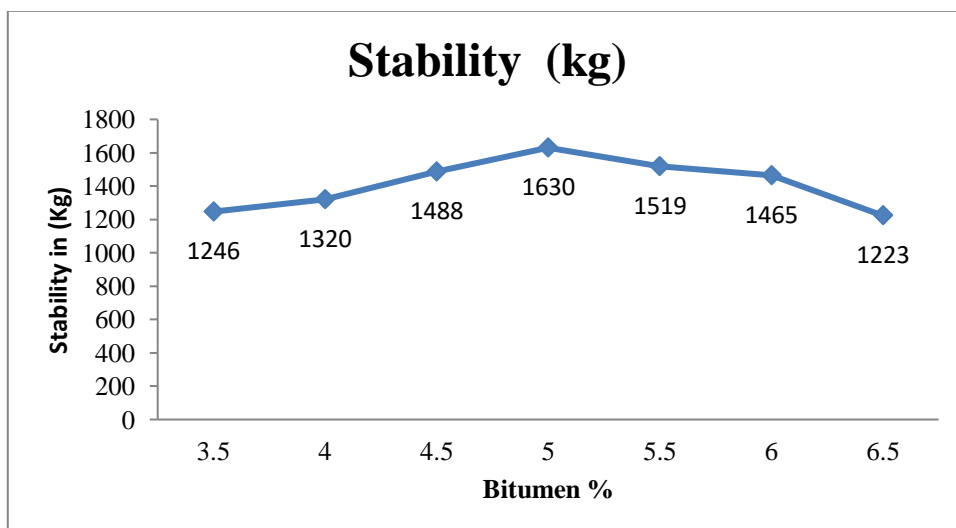


**Fig. 2: Variation of ductility value with waste plastic**



**Fig. 3: Variation flash and fire point with waste plastic**

**4.2 Marshall Stability and flow value without plastic**



**Fig. 4: Variation of stability with waste without plastic**

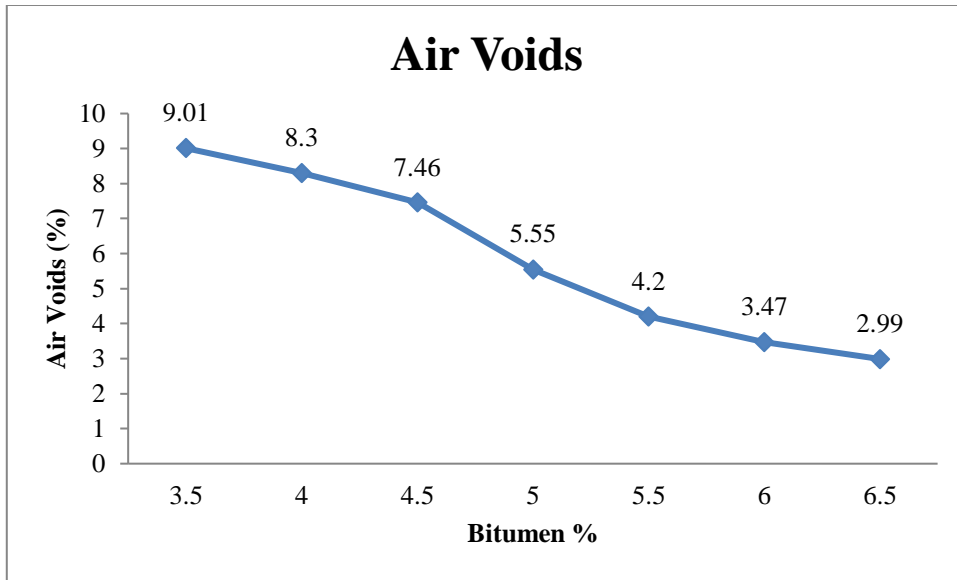


Fig. 5: Variation of air voids with waste without plastic

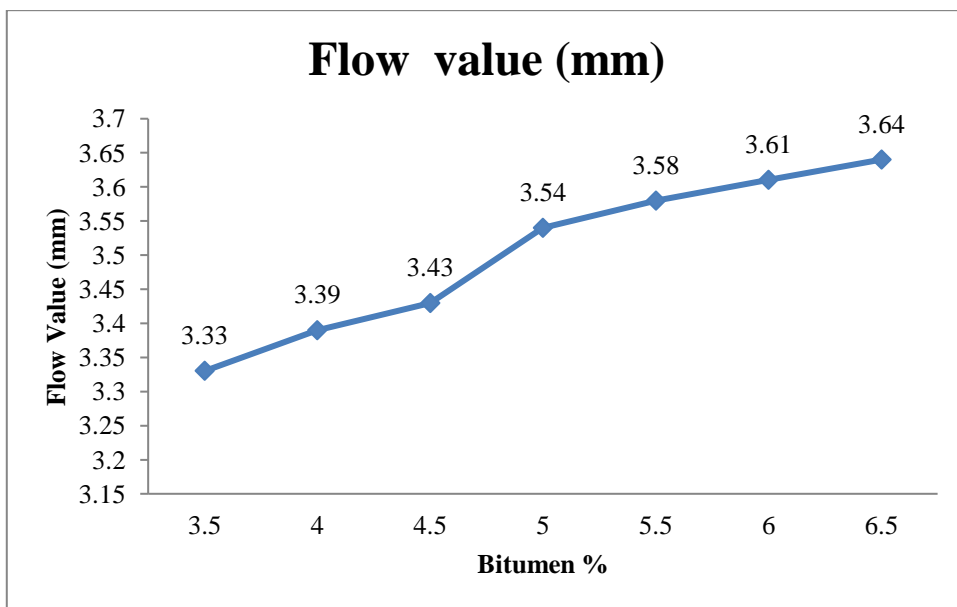


Fig. 6: Variation of flow value with waste without plastic

#### 4.3 Marshall Stability and flow value with plastic

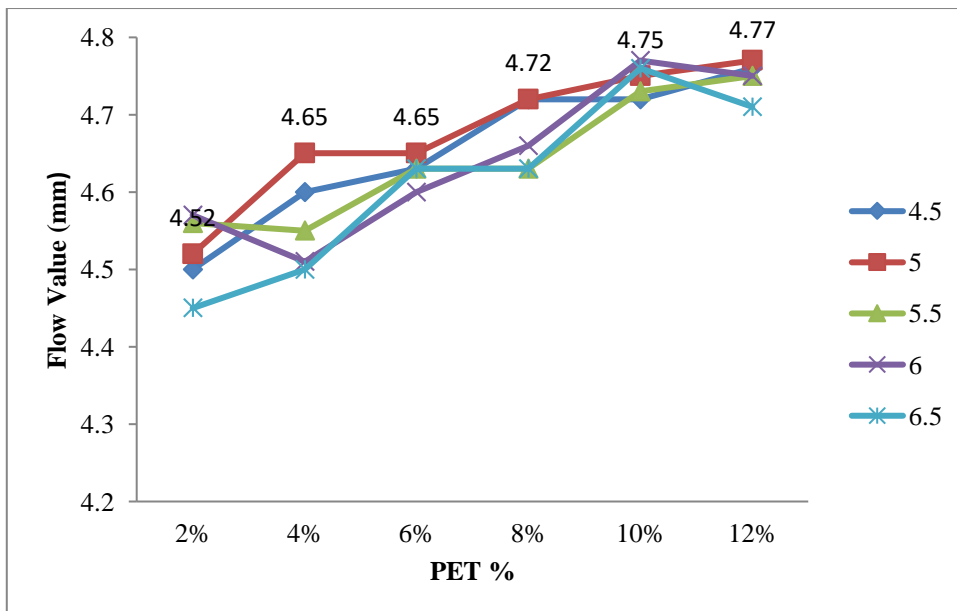
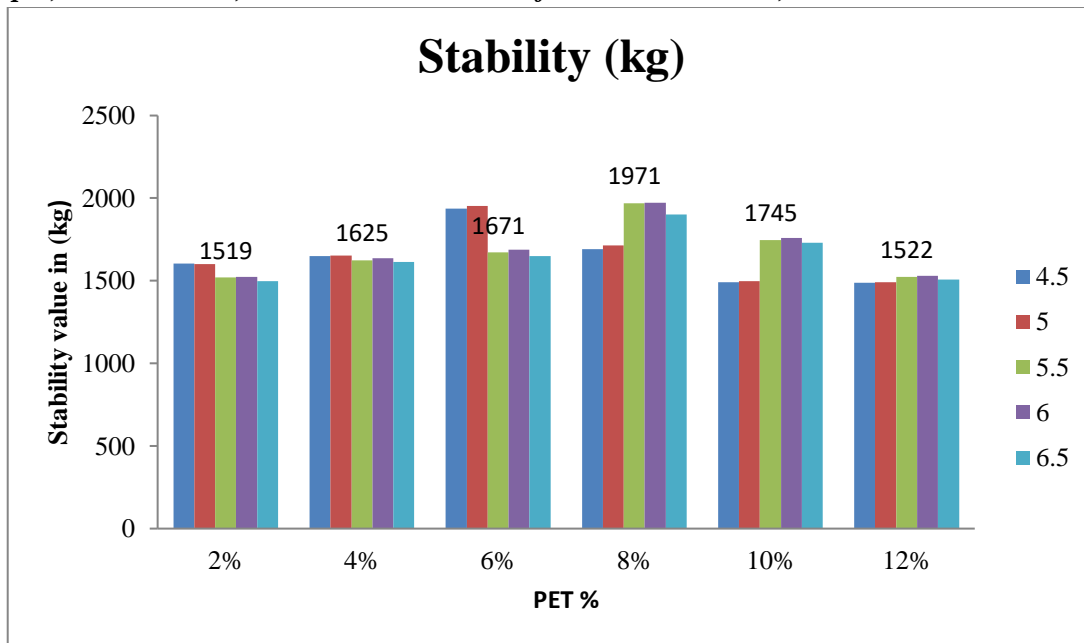


Fig. 7: Variation of flow value with waste plastic



**Fig. 8: Variation of stability with waste plastic**

## 5. CONCLUSIONS

In the current investigation, waste plastic was used to examine the performing basic tests such as Penetration, Ductility, Softening Point, Flash and Fire Point, and Marshall Stability Values Tests. Some of the significant conclusions and observations emerging from the present study are given below.

- The present stabilization process is very effective in controlling environmental pollution because the waste materials were completely recycled without any adverse impact on the environment. This study also encourages the mass scale utilization of PET
- Waste plastic can be efficiently used to produce good quality bitumen mix with satisfactory properties. The test results show that results are within the permissible limits prescribed by the IS Standards.
- Under certain conditions, the addition of waste plastic in bitumen appears to increase the strength and stability of bitumen pavement
- The results of the study indicated that the modified mixture has a better result compared to the non-modified mixture. By adding waste plastic to the bitumen, a better binding between binder and aggregates was obtained
- It is observed that the penetration values of plain bitumen decrease on increase of the waste plastic content. The results also show that the addition of waste plastic makes the modified bitumen harder and more consistent than plain bitumen which results in an improvement in the rutting resistance of the mix
- It is observed that the ductility of plain bitumen increases with the addition of plastic as compared to the plain bitumen.
- It is observed that the flashpoint value increases with increases percentage of plastic also fire point respectively.
- It was observed that Marshall Stability value increasing up to 5% bitumen uses without adding waste plastic. Also, clear that with adding plastic than Marshall Stability is higher of 5% bitumen and 8% plastic compare from normal mix respectively. After the increasing percentage of waste plastic with decreasing the stability of bitumen.
- It is observed that the Marshal Stability value is Maximum at 8% of plastic added in bitumen at 5% adding bitumen.
- It was observed that air void value decreasing with an increasing percentage of bitumen without plastic.

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