



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: III Month of publication: March 2018

DOI: <http://doi.org/10.22214/ijraset.2018.3273>

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Experimental Study on Flexible Pavement Using Synthetic Organic Material (Plastic).

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Abstract: *The contemporary asphalt roads were first developed in the early 20th century. These bituminous roads are still successful all over the world. Though the roads are successful they also have some flaws. In India the roads are famous for their bumps and pot holes. On the other hand, the day-today increase in plastic waste in the environment leads to a serious crisis to the environment. A solution to solve both the problems is combining both i.e., constructing the roads using plastic waste. The use of various materials in the road construction has been a trend since a while. Referring the code book IRC: SP: 053:2010 (guidelines on use of modified bitumen in road construction) the properties of the bitumen is tested for different proportions of bitumen and plastic. The test conducted are Softening point, Ductility, Penetration, Viscosity, Flash & fire point. The strength test such as Marshall stability test was also conducted. Based on the results obtained from the tests it was found that the strength of the bituminous road added with plastic has a higher strength than the normal bituminous road. As a test results for penetration test, Marshall stability, softening point, flash and fire point test the value for the bitumen with 10% plastic is optimum. For the result of ductility test, viscosity test the value for the bitumen with 15% is optimum. Finally, on overall comparison the bitumen when added with 10% plastic is more considerable and exhibits higher strength. Hence so we conclude that bitumen when added with plastic is more stable and efficient when compared to normal bituminous roads.*

Keywords: *Roads, plastic, combination of plastic and bitumen, testing of materials, strength test.*

I. INTRODUCTION

The disposal of different wastes produced from different Industries is a great problem which pose an environmental pollution in the nearby locality because many of them are non-biodegradable. For the construction of roads various materials such as bitumen, sand ballast are used generally. Though construction of roads are been in process for about 2 decades and is still in process, for the past decades the use of the vehicle is have been drastically increased which affects the condition of roads heavily, in India the roads are famous for their bumpy ride. the main reason for the formation of cracks and path removal of the roads is due to the poor binding between the ballast and the bitumen. This condition can be changed by adding some alternative to the road construction process. To improve the condition of road plastic can be incorporate into the road construction along with the bitumen.

A. Types Of Plastics

The plastic is generally classified into two types 1. thermoset plastic 2. thermoplastic. Thermoset plastic solidifies (or) sets irreversibly when heated, they are useful for their durability and strength. These plastics are polyethylene, polypropylene, polyamide, polyoxymethylene and polytetrafluorethylene. A thermoplastic softens when exposed to heat and returns to original condition at room temperature. Thermoplastics can easily be shaped and molded, which is toxic in nature. In order to contain this problem experiments have been carried out whether this waste plastic can be reused productively.

This experimentation provides that thermoplastics when heated and added along with bitumen becomes a good binder component and holds the ballast and bitumen together.

B. Characteristics Of Plastics

Plastic is a good binding compound. It has high ductility. Plastic when melted is becomes more adhesive and when mixed with the ballast the get hold to them tightly. plastic reduces the cohesion property of the bitumen which helps in self compaction of the mix and aligning of the roads.

C. Advantages of plastic in road construction:

- 1) The plastic are easily available in the environment
- 2) The plastic extends the life span of the roads
- 3) The use of plastic is an eco-friendly process

- 4) The plastic is a good binder content and reduces cracking
- 5) Non -polluting to the environment
- 6) High strength can be achieved to the roads.

D. Disadvantages of Plastic in road Construction

- 1) Using plastic in roads reduces the rain water penetration into the ground so special provision should be made
- 2) Since water cannot be penetrated into the ground the problem of water logging may arise
- 3) Temperature changes may cause some damage to the roads as plastic may expand and shrinks.

E. Objectives

- 1) To find the strength of modified bituminous roads
- 2) To compare the results of modified bituminous roads and normal bituminous roads.

II. METHODOLOGY

To find the root cause for the failure of roads, the main cause for the failure of roads is the bonding between the bitumen and the ballast. Thus we have to find a way to increase the binding capacity of the bitumen and aggregate. To increase the strength of the roads we have to find an alternative material which can be used as a good binder the plastic has a good binding capacity. The plastic can be added to the bitumen to increase the binding capacity of the roads. the plastic is collect from the near by household ragpickers, milk covers plastic recyclable bottles etc., these plastics are cleaned thoroughly before use. The cleaned plastic is then shredded for mixing with the plastic. The shredded plastic is then heated. These plastics usually melts at a temperature between 160°C-170°C. Bitumen is heated till the temperature of 160°C-170°C and it is maintained. the shredded plastic is the added to the bitumen piece by piece. and mixed till it gets mixed thoroughly. The bitumen mixes for different composition of plastic are made such as 10% plastic and 15% plastic. This plastic bitumen mix are further tested of material testing and strength testing. After the testing is done the results are compared with each other and an optimum result for roads construction ie., the composition at which higher results are achieved are noted and reported.

III. MATERIALS

The main ingredients for road constructions are ballast of different sizes such as 20mm, 10mm, fine dust. To hold these ballasts together a binder content is required for which bitumen can be used. Usually the bitumen asphalt is used for road construction. In addition to these general materials another binder materials are added that is plastic.

IV. TESTS AND RESULTS.

For testing of the bituminous roads the test usually is of two types 1. material testing 2. strength testing.

A. Material testing

First the materials must be tested there are various test available for testing the materials. they are

- 1) *Penetration Test:* Penetration test indicates the hardness or consistency of the bitumen. Higher the penetration value lower will be the consistency. A grade 80/100 refers that the penetration values lies between 80 to 100. so the grading of the bitumen greatly depends on the penetration value.



Fig.1 Penetration Test

- 2) *Viscosity Test:* Viscosity is the property of a material to resist the flow. Viscosity is the inverse of fluidity. The degree of fluidity at the application temperature greatly influences the ability of bituminous material to spread, penetrate into voids and also coat the aggregate and hence affect the strength and characteristics of resulting paving mixes. At high fluidity or low viscosity, bitumen binder simply lubricates the aggregate particles instead of providing a uniform film thickness for binding action. Low fluidity or high viscosity does not enable the bitumen to coat the entire surface of aggregate in the mix easily and also resists the compactive effort and resulting mix is heterogeneous in character.



Fig. 2 viscosity test

- 3) *Ductility Test:* Ductility of bitumen is its property to elongate under traffic load without getting cracked in road construction works. Ductility test on bitumen measures the distance in centimeters to which it elongates before breaking. Apparatus required, theory, procedure, precautions, observations, reporting and recommended values of bitumen ductility is discussed in this article. The ductility test gives a measure of adhesive property of bitumen and its ability to stretch. In flexible pavement design, it is necessary that binder should form a thin ductile film around aggregates so that physical interlocking of the aggregates is improved. Binder material having insufficient ductility gets cracked when subjected to repeated traffic loads and it provides pervious pavement surface. Ductility of a bituminous material is measured by the distance in centimeters to which it will elongate before breaking when two ends of standard briquette specimen of material are pulled apart at a specified speed and specified temperature.



Fig. 3 ductility test

- 4) *Softening Point Test:* The Softening Point of bitumen or tar is the temperature at which the substance attains particular degree of softening. As per IS: 334-1982, it is the temperature in °C at which a standard ball passes through a sample of bitumen in a mould and falls through a height of 2.5 cm, when heated under water or glycerine at specified conditions of test. The binder should have sufficient fluidity before its applications in road uses. The determination of softening point helps to know the temperature up to which a bituminous binder should be heated for various road use applications. Softening point is determined by ring and ball apparatus.



Fig. 4 softening point test.

5) *Flash And Fire Point Test:* Bituminous material leaves out volatiles at high temperatures depending upon their grade. These volatile vapours catch fire causing a flash. The flash point is the lowest temperature at which flash occurs due to ignition of volatile vapours when a small flame is brought in contact with the vapours of a bituminous product, gradually heated under standardized condition. When bituminous material is further heated to a higher temperature, the material itself catches and continues to burn; the lowest temperature causing this is the fire point. Fire point is always higher than flash point. The flash point of a material is the lowest temperature at which vapours of a substance momentarily take fire in the form of flash. The fire point is the lowest temperature at which the material gets ignited and burns under specific conditions of test.



Fig. 5 flash and fire point test.

B. Strength testing

This type of testing is done to find the strength of a materials.

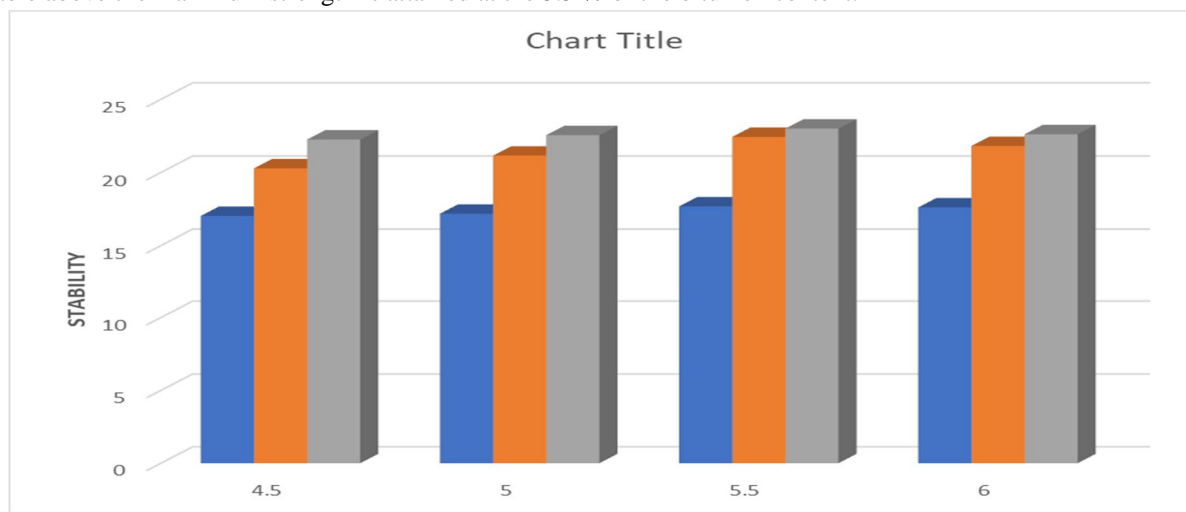
1) *marshall stability test:* the Marshall stability and flow test provides the performance prediction measure for the Marshall mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute. Load is applied to the specimen till failure, and the maximum load is designated as stability. During the loading, an attached dial gauge measures the specimen's plastic flow (deformation) due to the loading. The flow value is recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum load is recorded. The important steps involved in marshal mix design are summarized next.

BITUMEN CONTENT	STABILITY OF PLAIN BITUMEN	STABILITY OF BITUMEN 10% PLASTIC	STABILITY OF BITUMEN 15% PLASTIC
4.5%	17.03	20.08	22.25
5.0%	17.15	20.21	22.55
5.5%	17.68	22.43	23
6.0%	17.61	21.61	22.61



Fig. 6 marshall stability test

Based on the results obtained from the Marshall stability test of the normal bitumen and modified bitumen containing various concentrations of plastics a graph is drawn and according to the graph the maximum value gives the strength of the materials. Based on the table above the maximum strength is attained at the 5.5 % of the bitumen content.



bitumen conten graph for marshall stability

C. Comparative Analysis

All the results obtained the various tests are noted down and are compare for final comparison. The table below compares the result obtained in various test for bitumen and plastic added bitumen.

EXPERIMENT	NORMAL BITUMEN	BITUMEN & 10% PLASTIC	BITUMEN & 15% PLASTIC
Penetration test	68mm	58mm	88mm
Ductility test	83cm	52cm	100cm
Viscosity test	360sec	890sec	1000sec
Flash point	235	250	220
Fire point	251	270	250
Softening point	53	64	40
Marshall stability test	17.68	22.43	23

Table for the comparison of the results.

According to the code book IRC:SP:053:2010, the values of the test results are compared with the table .2 Properties of modified bitumen (page no. 7). The values having an approximate values as of the table is consider to be the best results. After the comparison of the results obtained it is observed that when the plastic is added to the bitumen its strength is considerably increased. As per our results we conclude that the bitumen containing 10% plastic is more suitable than the normal bitumen and the bitumen containing 15% plastic.

V. CONCLUSION

Based on the results obtained from the comparative analysis a conclusion can be made for the strength and durability on the bituminous roads.

As per the penetration test result values obtained the value of the bitumen with 10% plastic is more efficient. As per the viscosity test values obtained the viscosity value of the bitumen sample with 15% plastic is more optimum. As per the ductility test the value of the bitumen sample with 15% plastic is more efficient. As per the softening point test the values obtained from the bitumen sample with 10% plastic is more efficient. As per the results from the flash and fire point test the values indicate that the bitumen sample with 10% plastic is more efficient. As per the Marshall stability test results obtained the values of bitumen with 10% plastic and the bitumen containing 15% plastic only have slight variation at 5.5% of bitumen content.

Overall comparison of the results implies that results obtained from the bitumen sample with 10% plastic is more optimum when compared to the results obtained from the bitumen sample containing 15% plastic.

Thus we conclude that adding plastic to the bitumen increases the strength more than the normal bitumen only sample, that to the sample containing 10% plastic is more optimum for usage.

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