

Study on Characteristics of VG30 Grade Bitumen Mixed with Waste Plastics

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Abstract: Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. 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. Plastics are user friendly but not eco-friendly as they are non-biodegradable generally, it is disposed by way of land filling or incineration of materials which are hazardous. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment.

Keywords: Bitumen characteristics, plastic wastes, super pave, flexible pavements.

I. INTRODUCTION

Flexible Pavement is composed of bituminous material surface course and underlying base and sub-base courses. The bituminous material is more often asphalt whose viscous nature allows significant plastic deformation. The flexible pavement design is based on the load distributing characteristics of a layered system. It transmits load through a combination of layers. Flexible pavement distributes load over a relatively smaller area of the sub-grade beneath. The advantage of flexible pavement is that it can be opened for traffic within 24 hours after completion. Also the repair and maintenance is easy and cost effective.

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as 'Plastic'. Plastics can stay unchanged for as long as 4500 years on earth with increase in the global population and the rising demand for food and other essentials, there has been a rise in the amount of waste being generated daily by each household. Plastic in different forms is found to be almost 5% in municipal solid waste, which is toxic in nature. It is a common sight in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. Due to its biodegradability it creates stagnation of water and associated hygiene problems.

This study presents the proper utilization of waste in hot bitumen and aggregate to enhance pavement performance, to protect environment and to provide low cost roads.

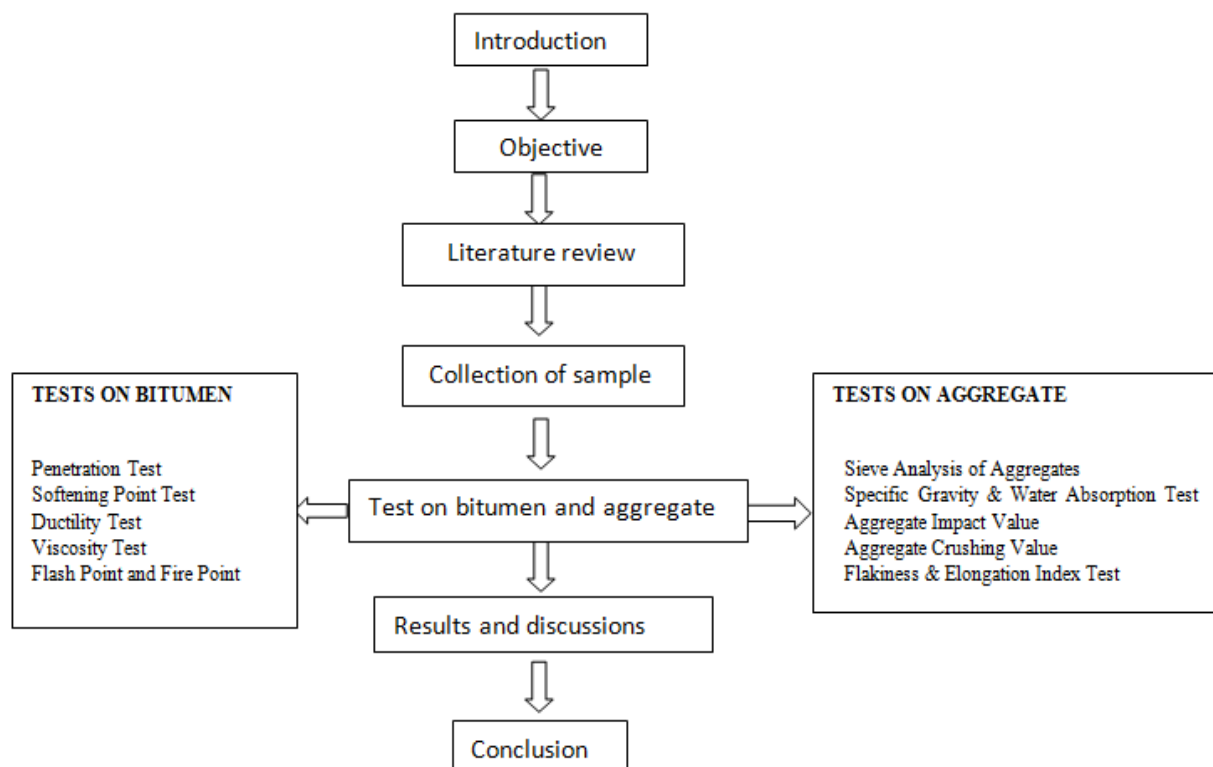
II. LITERATURE REVIEW

The concept of using plastic in flexible pavement has been done since several years ago in India. Plastic has played a very vital role in increasing the strength of bitumen as well as aggregate. Prof. C.E.G. Justo states that addition of plastic in bitumen improves the stability, strength, life and other desirable properties of bitumen. Similarly, Dr. R. Vasudevan states

that the polymer bitumen blend is a better binder compared to plain bitumen. Rema Devi et. all. Stated that the concept of utilization of waste plastic in the construction of pavement has shown better resistance to water which reduces the stripping of bitumen from aggregate. Amit Gawande et.al, investigations the use of waste plastic in road construction as an effective way to reutilize the plastic waste.

Prof. Avula Vamshi states that the addition of waste plastic modifies the properties of bitumen. The modified bitumen shows good result when compared to standard results. The optimum content of waste plastic to be used is between the ranges of 5% to 10%. The problems like bleeding are reduce in hot temperature region. Plastic has property of absorbing sound, which also help in reducing the sound pollution of heavy traffic. The waste plastics thus can be put to use and it ultimately improves the quality and performance of road. Total material cost of the project is reduced by 7.99%.

III. STUDY METHODOLOGY



TESTS ON AGGREGATE:

- Sieve Analysis of Aggregates
- Specific Gravity & Water Absorption Test [IS: 2386 (Part 3) 1963]
- Aggregate Impact Value Test [IS: 2386 (part 4) 1963]
- Aggregate Crushing Value [IS: 2386 (Part 4) 1963]
- Flakiness & Elongation Index Test [IS: 2386 (part 1) 1963]

TESTS ON BITUMEN:

- Penetration Test [Is: 1203-1978]
- Softening Point Test [Is: 1205-1978]
- Ductility Test [IS: 1208-1978]
- Viscosity Test
- Flash Point and Fire Point

IV. EXPERIMENTAL ANALYSIS

PREPARATION OF DESIGN MIX:

BINDER:

Generally binders are selected based on some simple tests and other site-specific requirements. These tests could be different depending of the type of binder viz. penetration grade, cutback, emulsion, modified binder etc. For most of these tests, the test conditions are pre-fixed in the specifications. Temperature is an important parameter which affects the modulus as well as the aging of binder. Super-pave specifications [Super-pave 1997, 2001] suggest that these acceptability tests are to be carried out at the prevalent field temperatures, not in a laboratory specified temperature.

Bitumen is a common binder used in the road construction. It is principally obtained as a residual product in petroleum refineries after higher fractions like gas, petrol, kerosene and diesel, etc., are removed. An Indian standard institution defines Bitumen as a black or dark brown non-crystalline soil or viscous material having adhesive properties derived from petroleum crude either by natural or by refinery processes.

AGGRERGATE:

Number of tests is recommended in the specifications to judge the properties of the aggregates, e.g. strength, hardness, toughness, durability, angularity, shape factors, clay content, adhesion to binder etc. Angularity ensures adequate shear strength due to aggregate interlocking, and limiting flakiness ensures that aggregates will not break during compaction and handling.

Aggregate is one of the most important materials used for flexible pavement construction. Properly selected and graded aggregates are mixed with bitumen to form hot mix asphalt (HMA) pavements. Aggregates are the principal load supporting components of HMA pavement. HMA can be divided into three types according to their size: coarse aggregate that generally retain on 2.36 mm sieve, fine aggregate are which pass through 2.36 mm sieve and retaining on 0.0075 mm sieve and mineral filler are the aggregate the one which pass through 0.075 mm sieve.



COATED BITUMINOUS MIX:

The generation of waste plastics is increasing day by day. The plastic coated aggregate bitumen mix and bitumen forms better materials for flexible pavement construction as the mixes shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods of easy disposal of waste plastics. The use of polymer coated aggregate is better than the use of polymer modified bitumen in many aspects. The studies on the thermal behaviour and binding property promoted a study on the preparation of plastic waste-bitumen blend and its properties to find the suitability of the blend for road construction.



DRY PROCESS:

- Waste plastic bags collect first.
- Collected plastic waste sorted as required thickness.
- Normally polyethylene 60 micron or below is used for the further process.
- Generally less micron plastic is easily mixable in the bitumen at higher temperature (160-170⁰c)
- Collected plastic was cut into fine pieces as far as possible.
- Then sieve it through 4.75mm sieve and retain on 2.36mm sieve was collected.
- First aggregate is heated at about 160-170⁰ c temp which is melting temperature of plastics.
- Then piece were added into this.
- At constant temp mixture was stirred manually for about 20-30min.
- Then hot bitumen of temperature around 160⁰c is added to the coated aggregate.

TEST ON AGGREGATES:

Toughness is the property of a material to resist impact. Due to traffic load and intensity, the road stones are subjected to various actions leading in formation of pounding impact or breaking into smaller pieces. Thus, road stones should therefore be tough enough to resist fracture under impact. Hence, a test is designed to evaluate the toughness of stone. The results of Impact, Crushing, Abrasion and Specific gravity test in aggregates are shown in Table.

CRUSHING STRENGTH TEST	20.3
IMPACT TEST	17.6
FLAKINESS TEST	25
ELONGATION TEST	11.1
LOS ANGELS ABRASION TEST	12

TEST ON BITUMEN:

Bitumen is a mixture of Organic Liquids that are highly Viscous, Black, Sticky, Entirely Soluble in Carbon Disulfide, and composed primarily of highly condensed Polycyclic Aromatic Hydrocarbons. Naturally occurring or crude bitumen is a sticky, tar-like form of petroleum which is so thick and heavy that it must be heated or diluted before it will flow. At room temperature, it is much like cold molasses. Refined Bitumen is the residual (bottom) fraction obtained by fractional distillation of crude oil. It is the heaviest fraction and the one with the highest boiling point, boiling at 525 °C (977 °F).

This study on the behaviour and binding properties enhanced for the preparation of plastic waste-bitumen blend to find suitability properties of material for road construction.

MARSHALL STABILITY TEST:

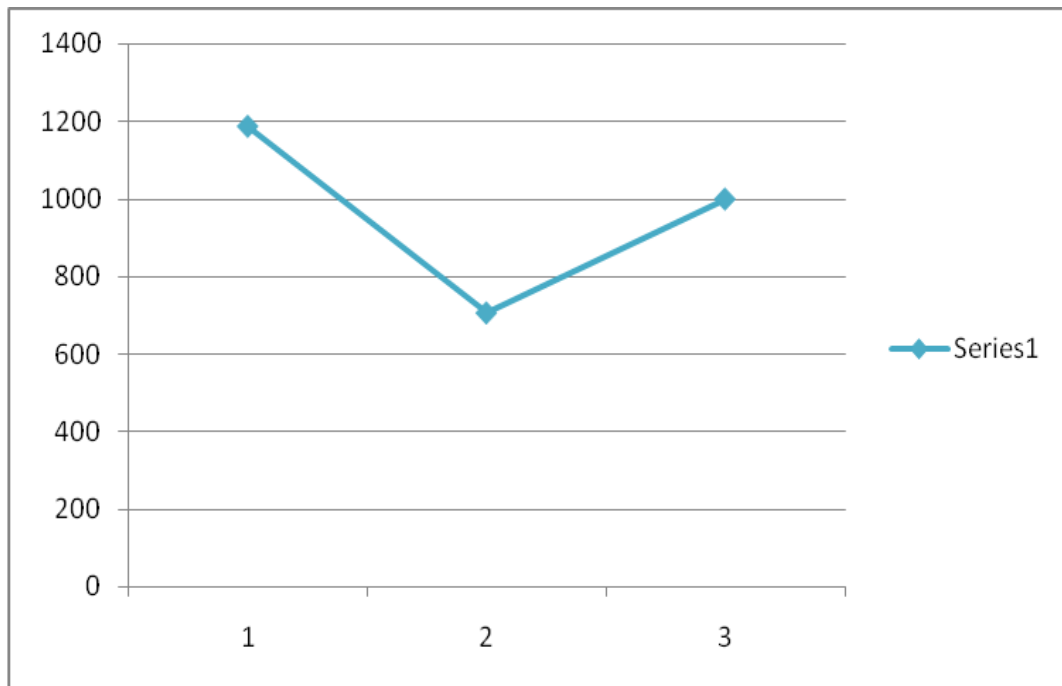
In marshal stability test, the deformation of specimen of bituminous mixture is measured when the same load is applied. This test procedure is used in designing and evaluating bituminous paving mixes. The marshal stability of mix is defined as a maximum load carried by a compacted specimen.



The following results of Marshal Stability test are shown in Table

S.NO	PLASTIC ADDED(%)	STABILITY(kg)
1	Without plastics	1187.19
2	8	706.07
3	10	999.74





The Graph is drawn between Plastic Content and Stability.

- 1 - Without Plastics
- 2 - 8% Plastic
- 3 - 10% Plastic

V. CONCLUSION

- It shows that with the increase of waste plastic in bitumen increases the properties of aggregate and bitumen.
- Use of waste plastic in flexible pavements shows good result when compared with conventional flexible pavements.
- This has added more value in minimizing the disposal of plastic waste as an eco-friendly technique.
- Coating of polymer on the surface of the aggregate has resulted in many advantages, which ultimately helps to improve the quality of flexible pavement.
- From the Marshall stability test study, the stability of the flexible pavements is improved with the addition of various proportions of the plastic wastes.
- The better performance of the pavement is assumed to be when the waste plastic added is in 8 to 10% range, thus sustainable super pave can be constructed.

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