Performance Evaluation of Recycled Bitumen Before And After The Addition of Plastic Waste At Laboratory

Ravuri. Suresh Babu[1], V. Hemanth Kumar[2]

[1]M-Tech, transportation engineering), Civil Engineering, sanketika vidya parishad engineering College, vishakapatnam, Andhra Pradesh, India.
[2]Asst Professor, Civil Engineering Department sanketika vidya parishad engineering College, vishakapatnam, Andhra Pradesh, India.

Abstract:
The main objective of our research is to characterize the bitumen which has been extracted from selected roads before and after the addition of plastic waste through the determination of engineering properties. Were carried out on three samples from each of the roads in order to obtain extracted bitumen characteristics. The extracted bitumen percentage from the mix was 5-6%, which fell within the specified range (percentage) of 5-8%. The Plastic waste in Municipal Solid Waste is been increasing day by day due to increase in Population, Urbanization, development activities, which is leading to wide spread of land use for the disposal of waste. Thus these wastes are not disposed scientifically there will be a possibility to create ground water pollution and also leads to the loss of fertile soil. Thus our project focuses on using the plastic waste as well as used bitumen rather than to dispose them. Thus we even reduce ground water pollution and also reduce soil degradation. Thus we added plastic waste to the recycled bitumen and the mix obtained so showed better binding property, stability, density and more resistant to water.

Keywords: Plastic, Bitumen, Binding Property, Stability, Density.

INTRODUCTION

Bituminous binders are widely used by paving industry. In general pavements are categorized into 2 groups, i.e. flexible and rigid pavement.

Flexible Pavement

Flexible pavements are those, which on the whole have low flexural strength and are rather flexible in their structural action under loads. These types of pavement layers reflect the deformation of lower layers on-to the surface of the layer.

Rigid Pavement

If the surface course of a pavement is of Plain Cement Concrete then it is called as rigid pavement since the total pavement structure can't bend or deflect due to traffic loads. Pavement design and the mix design are two major considerations in case of pavement engineering. The present study is only related to the mix design of flexible pavement considerations. The design of asphalt paving mixtures is a multi-step process of selecting binders and aggregate materials and proportioning them to provide an appropriate compromise among several variables that affect mixture behavior, considering external factors such as traffic loading and climate conditions.

BITUMINOUS MIX DESIGN

Overview

The bituminous mix design aims to determine the proportion of bitumen, filler, fine aggregates, and coarse aggregates to produce a mix which is workable, strong, durable and economical. There are two types of the mix design, i.e. dry mix design and wet mix design.

Objective of Bituminous mix design

Main objectives of bituminous mix design are to find;

1. Optimum bitumen content to ensure a durable pavement,
2. Sufficient strength to resist shear deformation under traffic at higher temperature,
3. Proper amount of air voids in the compacted bitumen to allow for additional compaction done by traffic,
4. Sufficient workability, and
5. Sufficient flexibility to avoid cracking due to repeated traffic load.

Requirements of bituminous mixes

Bituminous mixture used in construction of flexible pavement should have following properties;

1. Stability
2. Durability
3. Flexibility
4. Skid resistance
5. Workability

Different layers in a pavement

In bituminous binder course a bituminous-aggregate mixture is used as an intermediate course between the base and surface courses or as the first bituminous layer in a two-layer bituminous resurfacing.

Asphaltic/Bituminous concrete consists of a mixture of aggregates continuously graded from maximum size , typically less than 25 mm, through fine filler that is smaller than 0.075 mm. Sufficient bitumen is added to the mix so that the compacted mix is effectively impervious and will have acceptable dissipative and elastic properties.

POLYMER MODIFICATION

Present Scenario

Bituminous binders are widely used in road paving and their viscoelastic properties are dependent on their chemical composition. Now-a-days, the steady increment in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature put us in a situation to think about some alternative ways for the improvement of the pavement characteristics and quality by applying some necessary modifications which shall satisfy both the strength as well as economical aspects. Bitumen can also be modified by adding different types of additives to achieve the present requirement. One of these additives is the polymers

Waste plastic: the problem

Today availability of plastic waste is enormous. The use of plastic materials such as carry bags, cups, etc is constantly increasing. Nearly 50% to 60% of total plastic are consumed for packing. Once used, plastic packing materials are thrown outside and they remain as waste. Plastic wastes are durable and non-biodegradable. The improper disposal of plastic may cause breast cancer, reproductive problems in humans and animals, genital abnormalities and much more. These plastic wastes get mixed with water, disintegrate, and take the forms of small pallets which cause the death of fishes and other aquatic life who mistake them as food material. Sometimes they are either land filled or incinerated. Plastic wastes get mixed with the municipal solid waste or thrown over a land area.

Role of polyethylene in bituminous pavements

Use of polyethylene in road construction is not new. Some aggregates are highly hydrophilic (water loving). Like bitumen polyethylene is hydrophobic (water hating) in nature. So the addition of hydrophobic polymers by dry or wet mixing process to asphalt mix lead to improvement of strength, water repellent property of the mix. Polyethylene's get added to hot bitumen mixture and the mixture is laid on the road surface like a normal tar road. Plastic roads mainly use plastic carry-bags, disposable cups, polyethylene packets and PET bottles that are collected from garbage as important ingredients of the construction material.

PROPERTIES OF MODIFIED BITUMINOUS CONCRETE

Advantages

- Better resistance towards rain water and water stagnation.
- No stripping and no pot holes.
- Reduce the need of bitumen by around 10%

Disadvantages

- Toxics present in the co-mingled plastic would start leaching.
- But the presence of chlorine will definitely release noxious HCL gas.

OBJECTIVE STUDY

- To check the properties of bituminous mix specimen.
- To check the properties of bituminous mix specimen due to coating of waste plastic materials.
- To identify the optimum proportion of waste plastic is to be added in the bitumen mix for getting the required strength.

SCOPE OF THE PROJECT

- To eradicate pot holes.
- To minimize the global warming, greenhouse gases and pollution.
- The lifespan of the roads can be increased.
- Eco-friendly in nature. .

I. REVIEW CRITERIA

Bindu and Beena (2010) studied how Waste plastic acts as a stabilizing additive in Stone Mastic Asphalt when the mixtures were subjected to performance tests including Marshall Stability, tensile strength, compressive strength tests and Tri-axial tests. There results indicated that flexible pavement with high performance and durability can be obtained with 10% shredded plastic.

Fernandes et al. **(2008)** studied Rheological evaluation of polymer modified asphalt binders by using thermoplastic elastomer styrene butadiene styrene (SBS) and they compared the properties of Modified binder by addition of both oil shale and aromatic oil to improve their compatibly. The rheological characteristics of the SBS PMBs were analyzed in a dynamic shear rheometer (DSR) and the morphology accessed by fluorescence optical microscopy. The results indicated that the aromatic and shale oils have similar effects on the microstructure, storage stability and viscoelastic behaviour of the PMBs. Thus, shale oil could be successfully used as a compatibilizer agent without loss of properties or could even replace the aromatic oil.

Awwad and Shbeeb (2007) indicated that the modified mixture has a higher stability and VMA percentage compared to the non-modified mixtures and thus positively influence the rutting resistance of these mixtures. According to them modifying asphalt mixture with HDPE polyethylene enhances its properties far more than the improvements realized by utilizing LDPE polyethylene.

II. METHODOLOGY

Bituminous mix consists of a mixture of aggregates continuously graded from maximum size, typically less than 25 mm, through the fine filler that is smaller than 0.075mm. Sufficient bitumen is added to the mix so that the compacted mix is effectively impervious and will have acceptable dissipative and elastic properties. The bituminous mix design aims to determine the proportion of bitumen, filler, fine aggregates, and coarse aggregates to produce a mix which is workable, strong, durable and economical. The basic materials used are as follows:

- Aggregates
- Lime
- Bituminous Binder
- Polyethylene

MATERIALS USED IN PRESENT STUDY

Sieve Analysis of Aggregate

By passing the sample downward through a series of standard sieves, each of decreasing size openings, the aggregates are separated into several groups, each of which contains aggregates in a particular size range. This test is done to determine the particle size distribution of fine and coarse aggregates.

The apparatus used are

- A set of IS sieves of sizes-80 mm, 63 mm, 50 mm, 40 mm, 31.5 mm, 25 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 6.3 mm, 4.75 mm
- Balance are scale with accuracy to measure 0.1% of the weight of the test sample.
- The test sample is dried to a constant weight at a temperature of 110+5ºC and weighed.
- The sample is sieved by using set of IS sieves
- On completion of sieving, the materials on each sieve is weighed
- Cumulative weight passing through each sieve is calculated as apercentage of the total sample weight.
- Fineness modulus is obtained by adding cumulative percentage of aggregate retained on each sieve and dividing the sum by 100

Flakiness and Elongation Tests

The Flakiness index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than three- fifths (0.6times) of their mean dimension. This test is not applicable to sizes smaller than 6.3mm.

The Elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than nine-fifths (1.8times) their mean dimension. This test is not applicable for sizes smaller than 6.3mm.

The apparatus for the shape tests consists of the following:

- A standard thickness gauge
- A standard length gauge
- IS sieves of sizes 63, 50 40, 31.5, 25, 20, 16, 12.5,10 and 6.3mm
- A balance of capacity 5kg, readable and accurate up to 1 gm.
- Sieve the sample through the IS sieves.
- Take a minimum of 200 pieces of each fraction to be tested and weigh them.
- To separate the flaky materials, gauge each fraction for thickness on a thickness gauge.
- The width of the slot used should be of the dimensions specified for the appropriate size of the material.
- Weigh the flaky material passing the gauge to an accuracy of at least 0.1 per cent of the test sample.
- To separate the elongated materials, gauge each fraction for length on a length gauge. The width of the slot used should be of the dimensions specified for the appropriate size of the material.
- Weigh the elongated material retained on the gauge to an accuracy of at least 0.1 per cent of the test sample.

Aggregate Impact Value Test

The property of the material to resists impact is known as toughness. Due to movement of vehicles on the road the aggregate are subjected to impact resulting in their breaking down into smaller pieces. The aggregate should therefore have sufficient toughness to resists the disintegration due to impact. This characteristic is measured by impact value test. The aggregate impact value is a measure of resistance to sudden impact or shock, whichis equipped with a circular base with two vertical guides. This test accesses the suitability of aggregates in road construction on the basis of impact value. The Aggregate Impact Tester may differ from its resistance to gradually applied compressive.

Apparatus used in Impact test · A testing machine weighing 45 to 60 kg and having a metal base with a plane lower surface of not less than 30 cm in diameter.

- Bituminous surface dressing penetration macadam, bituminous carpet concrete
- Bitumen-bound-macadam, base course
- WBM base course with bitumen surfacing
- Cement Concrete base course
- The test sample shall consist of aggregate the whole of which passes a 12.5 mm IS Sieve and is retained on a 10 mm IS Sieve. The aggregate comprising the test sample shall be dried in an oven for a period of four hours at a temperature of 100 to 110°C and cooled.
- The measure shall be filled about one-third full with the aggregate and tamped with 25 strokes of the rounded end of the tamping rod. Further similar quantity of aggregate shall be added and a further tamping of 25 strokes given. The measure shall finally be filled to overflowing, tamped 25 times and the surplus aggregate struck off, using the tamping rod as a straight edge. The net weight of aggregate in the measure shall be determined to the nearest gram (Weight A).
- The impact machine shall rest without wedging or packing upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.
- The cup shall be fixed firmly in position on the base of the machine and the whole of the test sample placed in it and compacted by a single tamping of 25 strokes of the tamping rod.

- The hammer shall be raised until its lower face is 380 mm above the upper surface of the aggregate in the cup, and allowed to fall freely on to the aggregate. The test sample shall be subjected to a total of 15 such blows each being delivered at an interval of not less than one second.
- The crushed aggregate shall then be removed from the cup and the whole of it sieved on the
- 2.36 mm IS Sieve until no further significant amount passes in one minute. The fraction passing the sieve shall be weighed to an accuracy of 0.1 g (Weight. B).
- The fraction retained on the sieve shall also be weighed (Weight C) and, if the total weight (C+B) is less than the initial weight (Weight A) by more than one gram, the result shall be discarded and a fresh test made. Two tests shall be made.

Aggregate Crushing Value Test

The 'aggregate crushing value' gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. It is the percentage by weight of the crushed (or finer) material obtained when the test aggregates are subjected to a specified load under standardized conditions, and is a numerical index of the strength of the aggregate used in road construction. Aggregates with lower crushing value indicate a lower crushed fraction under load and would give a longer service life to the road and hence a more economical performance. Weaker aggregates if used would get crushed under traffic loads, would produce smaller pieces not coated with binder and these would be easily displaced or loosened out resulting in loss of the surface / layer. In short the aggregate used in road construction must strong enough to withstand crushing under roller and traffic.

- A steel cylinder 15 cm diameter with plunger and base plate.
- A straight metal tamping rod 16mm diameter and 45 to 60cm long rounded at one end.
- A balance of capacity 3 kg readable and accurate to one gram.
- IS sieves of sizes 12.5mm, 10mm and 2.36mm
- A compression testing machine.
- Cylindrical metal measure of sufficient rigidity to retain its from under rough usage and of 11.5cm diameter and 18cm height.
- Dial gauge
- put the cylinder in position on the base plate and weigh it **(W)**.
- Put the sample in 3 layers, each layer being subjected to 25 strokes using the tamping rod. Care being taken in the case of weak materials not to break the particles and weigh it **(W1)**.
- Level the surface of aggregate carefully and insert the plunger so that it rests horizontally on the surface. Care being taken to ensure that the plunger does not jam in the cylinder.
- Place the cylinder with plunger on the loading platform of the compression testing machine.
- Apply load at a uniform rate so that a total load of 40T is applied in 10 minutes.
- Release the load and remove the material from the cylinder.
- Sieve the material with 2.36mm IS sieve, care being taken to avoid loss of fines.
- Weigh the fraction passing through the IS sieve **(W2)**

Specific Gravity and Water Absorption Test

The specific gravity of an aggregate is an indirect measure of its strength, the more specific gravity the more is the strength, in general. Water absorption is expressed as percentage ratio of water absorbed to the weight of the oven dry aggregate. The water absorption of aggregates is needed in deciding the proportion of water in concrete while designing the mix.

TESTS FOR BITUMEN

Penetration Test

Penetration is a measurement of hardness or consistency of bituminous material. It is a vertical distance traversed or penetrated by the point of a standard needle into the bituminous material under specific condition of load, time and temperature. This distance is measured in one tenth of a millimeter. This test is used for evaluating consistency of bituminous materials

The bitumen is softened to a pouring consistency, stirred well, and poured into the test containers. The depth of bitumen in the container is kept at least 15mm more than the expected penetration. (I.S. 1203-1958). Related:- California Bearing Ratio(CBR Test) of Subgrade Soil - Procedure, apparatus, and use for pavement Design

- Now the sample containers are placed in a temperature-controlled water bath at a temperature of 25 c for one hour.
- Then at the end of one hour, the sample is taken out of water bath and the needle is brought in contact with the surface of bitumen sample at that time reading of dial is set at zero or the reading of dial noted, when the needle is in contact with the surface of the sample.
- After that, the needle is released and the needle is allowed to penetrate for 5 seconds and the final reading is recorded. On that sample at least three penetration observations should be taken at distances at least 10 mm apart. After each test, the needle should be disengaged, wiped with benzene, and dried. The amount of penetration is recorded as shown in Fig. 1.
- The main value of the three measurements is reported is the penetration test.
- The accuracy of the test depends upon pouring temperature, size of the needle, the weight placed on the needle, and test temperature.
- Te grade of bitumen is specified in terms of penetration value. For example, 30/40 grade bitumen indicates the penetration value of the bitumen in the range of 30 to 40 at standard test conditions.

Fig no: 01 Penetration Test

Softening Point Test

The softening of point of bitumen is the temperature at which the substance attains a particular degree of softening. As per IS: 334- 1982, it is the temperature (in °C) at which a standard ball passes through the sample of bitumen in a mould and falls through a height of 2.5 cm, when heated under water or glycerin 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.

- A brass shouldered ring
- A steel ball

- Ball centering guide
- Ring holder
- Brass pouring plate
- Water bath and thermometers

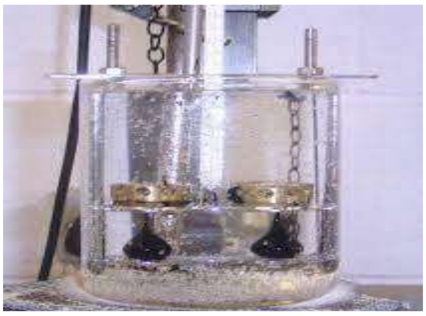

Fig no: 02. Softening Point Test

- The sample is first heated with continuous stirring until it becomes sufficiently fluid to pour.
- A slight excess of the heated sample is poured into two rings that have already been preheated to approximately the pouring temperature.
- The apparatus is then assembled with the rings, thermometer, ball centring guide, and filled with boiled water up to a depth not less than 102mm and not more than 108mm.
- The water bath temperature is then maintained at about 15 degree Celsius for about 15 minutes.
- Then, balls previously adjusted to the temperature are placed on the ball centring guide.
- The arrangement is heated at the rate of 5 degree Celsius per minute. It must be noted that the temperature rise is uniform.
- The maximum permissible variation of any 1mm period after the first 3mm shall be +0.5 degree or -0.5 degree. All the tests in which the rate of rising doesn't fall within these limits are rejected
- For each ring and ball, the thermometer reading is noted at the instant when the specimen surrounding the ball touches the base plate

Ductility Test

The ductility test gives a measure of adhesive property of bitumen and its ability to stretch. In a flexible pavement design, it is necessary that binder should form a thin ductile film around the aggregates so that the physical interlocking of the aggregates is improved. Binder material having insufficient ductility gets cracked when subjected to repeat traffic loads and it provides pervious pavement surface. The ductility of a bituminous material is measured by the distance in centimeters to which it will elongate before breaking when two ends of a standard briquette specimen are pulled apart at a specified speed and temperature. The apparatus as per IS: 1208-1978 consists

- **Briquette mould:** It is made of brass. Circular holes are provided at ends called clips to grip the fixed and movable ends of the testing machine. The mould when properly assembled form a briquette specimen of following dimensions:
- Total length 75.0 ± 0.5 mm
- Distance between clips 30.0 ± 0.3mm
- Width at mount of slip 20.0 ± 0.2mm
- Width at minimum cross-section (half way between clips) 10.0 ± 0.1mm

- Thickness throughout 10.0 ± 0.1mm

Water bath: A bath maintained within 27.0° ±0.1 °C of the specified test temperature containing not less than 10 liters of water, the specimen being submerged to a depth of not less than 10 cm and supported on a perforated shell and less than 5 cm from the bottom of the bath.

Testing machine: For pulling the briquette of bituminous material apart, any apparatus may be used which is so constructed that the specimen will be continuously submerged in water while the two clips are being pulled apart horizontally at a uniform speed of 50 ± 2.5 mm per minute.

Thermometer: Range 0-44°C and readable up to 0.2°C 3

Fig no: 03. Ductility Test

- Melt the bituminous test material completely at a temperature of 75°C to 100° C above the approximate softening point until it becomes thoroughly fluid.
- Strain the fluid through IS sieve 30
- After stirring the fluid, pour it in the mould assembly and place it on a brass plate. In order to prevent the material under test from sticking, coat the surface of the plate and interior surfaces of the sides of the mould with mercury or by a mixture of equal parts of glycerine and dextrine.
- After about 30-40 minutes, keep the plate assembly along with the sample in a water bath. Maintain the temperature of the water bath at 27° C for half an hour.
- Remove the sample and mould assembly from the water bath and trim the specimen by levelling the surface using a hot knife.
- Replace the mould assembly in water bath for 80 to 90 minutes.
- Remove the sides of the mould.
- Hook the clips carefully on the machine without causing any initial strain.
- Adjust the pointer to read zero.
- Start the machine and pull clips horizontally at a speed of 50 mm per minute.
- Note the distance at which the bitumen thread of specimen break

Flash and Fire Point Test

Flash and fire point test of bitumen sample is one of the important tests of bitumen to be conducted before road construction.

Flash and fire point measures the temperature at which the material is at risk of catching fire.

The temperature at which the vapor of the bituminous material catches an instant fire or the material burns for some seconds is different for different types and grades of bitumen binders.

Bituminous materials are primarily hydrocarbons and hence at high temperatures, they release various volatile materials. These liberated volatile compounds catch fire with a flash. And this can prove hazardous.

Bitumen is heated for its application as bitumen binder for road pavements.
While dealing with hot bitumen during the processes like heating, mixing, or application, the temperature should be kept well below the critical temperatures determined by flash and fire point.

Marshall Stability and Flow Introduction

In this method, the resistance to plastic deformation of a compacted cylindrical specimen of bituminous mixture is measured when the specimen is loaded diametrically at a deformation rate of 50 mm/min. Here are two major features of the Marshall method of mix design.

(i) Stability, flow tests and
(ii) Voids analysis.

The Marshall stability of the mix is defined as the maximum load carried by the specimen at a standard test temperature of 60°C. The flow value is the deformation that the test specimen undergoes during loading up to the maximum load. In India, it is a very popular method of characterization of bituminous mixes due to its simplicity and low cost. In the present study the Marshall properties such as stability, flow value, unit weight and air voids were studied to obtain the optimum binder contents (OBC) and optimum polyethylene contents (OPC).

The Marshall test method is widely used for the design and control of asphaltic concrete and hot rolled asphalt materials, it cannot be applied to open textured materials such as bitumen macadam. Materials containing aggregate sizes larger than 20 mm, are liable to give erratic results. The full Marshall method is a method of bituminous mix design in addition to being a quality control test. The details given below related mainly to its use as a quality control test. The suitability of materials for the design of Marshall Asphalt requires that a numbers of tests are performed on the materials. Tests normally performed are:

1. Asphalt: (a) Penetration (b) Viscosity (c) Solubility (d) Specific gravity (e) Fire & flash point (f) Softening point.

2. Aggregates: (a) Percent wear (b) Unit weight (c) Sieve analysis (d) Specific gravity (e) Absorption. The preliminary mix designs, the scheme for analyzing aggregate will be governed, to some extent, by method of producing the gradation during construction.

Apparatus

The samples are prepared in 100 mm diameter moulds which are fitted with a base and collar sample is compacted using a hammer consisting of a sliding weight which falls onto a circular foot during compaction the mould is held on a hardwood block which is rigidly fixed to a concrete base The sample is removed from the mould using an extraction plate and press and heated to the test temperature of 60° C in a water bath. The cylindrical specimens are tested on their sides between test heads similar to those. The flow is measured with a dial gauge and the stability is measured with a proving ring. A motorized load frame is required for the test.

Sample Preparation

If necessary, the aggregates should be oven-dried at 150°C before testing commences. it is first necessary to combine the various sample sizes to give the required grading for the mixed aggregate. Several different grading may be tried if a full Marshall mix design is to be carried out. When it is required to determine the most satisfactory bitumen content, given a sample of mixed aggregate, an
initial estimate of the required bitumen content can be made from knowledge of the compacted density of the Mixed Aggregate (CDMA). The CDMA is most conveniently determined using a standard 100 mm. diameter compaction mould and a 2.5 kg compaction hammer. The sample of dry aggregate is compacted in the mould in four layers, each layer being given 20 blows of the hammer. The density of the aggregate is

then calculated in an identical manner to the bulk density in a compaction tests. The average of two determinations is taken as the CDMA It is also necessary to carry out separate determinations of the specific gravity of the mixed aggregate (SGMA), and the specific gravity of bitumen.
The voids in mixed aggregate VMA are then determined from the formula:

$$VMA = [1 - \frac{G_{mb}}{G_{mm}} \times P_S] \times 100$$

The VMA should normally be between 17 and 20% for a satisfactory mix.

Voids filled with bitumen (VFB)

$$VFB = \frac{VMA - VA}{VMA} \times 100$$

Air voids (VA):-

$$VA = (1 - \frac{G_{mb}}{G_{mm}}) \times 100$$

Bulk specific gravity of mix (G_{mb})

$$G_{mb} = \frac{M_{mix}}{\text{Bulk volume of mix}}$$

Note. In bitumen calculations, it is usual to express all densities and specific gravities in gram/ml; gram/cc or Mg/cu.m. Having completed the required tests on the mixed aggregates, the bituminous material is then produced by mixing the aggregates with the bitumen in the correct proportions. For each test specimen, the required weight of mixed aggregate is weighed out and place in an oven at the temperature

Fig no: 04. Softening Point Test

III. RESULT AND DISCUSSION

Table.1 Physical properties of bitumen

Designation	Test Result	Permissible Limit	Test Method
Specific gravity of bitumen	1.025	0.99 min	IS: 1202 - 1978
Softening point of bitumen	54.35°C	47°C	IS: 1205 - 1978
Flash point of bitumen	272°C	220°C (min)	IS: 1209 - 1978
Fire point of bitumen	300°C	270°C (min)	IS: 1209 - 1978
Bitumen penetration test	50 mm	45 min	IS: 1203 - 1978
Ductility test	94 cm	100	IS: 1208 - 1978

Table.2 Sieve Analysis

Size	Upper Limits	Lower Limits	Mid Limits	Results
37.5	100	100	100	100.00
26.5	100	90	95	100.00

19	95	71	83	93.89
13.2	80	56	68	71.29
4.75	54	38	46	42.69
2.36	42	28	35	29.41
0.3	21	7	14	10.53
0.075	8	2	5	4.18

Table.3 Aggregate Test Result

Designation	Test Result	Test Method
Aggregate impact value test	23.80	IS: 2386 part
Specific gravity of aggregates (20 mm)	2.68	IS: 2386 part
Specific gravity of aggregates (10 mm)	2.71	IS: 2386 part
Specific gravity of aggregates (6 mm)	2.69	IS: 2386 part
Specific gravity of aggregates (stone dust)	2.74	IS: 2386 part
Stripping value of aggregates	45%	Physical appearance
Water absorption	0.40	IS: 2386 part

Table.4Characteristics of waste plastic

Polymer	Softening Temp. (C)	Products Reported	Decomposition Temp. (C)	Examples
Polyethylene (PE)	100-200	No gas	270-350	Bags, sacks, detergent bottles etc.
Polypropylene (PP)	140-160	No gas	270-300	Film wrapping of biscuits, chips
Polystyrene (PS)	110-140	No gas	300-350	Disposable glasses

Table.5Characteristic values at different bitumen contents

Mould No	Bitumen Content	Stability (Kg)	Average Stability (Kg)	Flow Value (Mm)	Average Flow Value (mm)
1	4.25%	822	822	2.8	2.93
2		931.6		3	
3		712.4		3	
4	4.50%	822	949.87	4	3.26
5		1013.8		2.4	
6		1013.8		3.1	
7		685		3.2	

8	4.75%	808.3	785.67	3.4	3.17
9		863.1		3.2	

Table.6Characteristic values of the specimens at 4.5% bitumen content.

Mould No	Bitumen Content	Plastic Content (%)	Stability (Kg)	Flow Value (Mm)	Va (%)	Vma (%)	Vfb (%)
1	4.50%	0	1098	2.8	4.5	15.5	71.2
2		6	861	2.77	3.9	15.2	72.2
3		8	947	2.6	4.5	15.6	71.2
4		10	1005	2.87	5.6	16.5	66.1
5		12	1059	3.23	5.9	16.8	64.8
6		14	966	3.5	7.2	18	59.8
LIMIT AS PER MORTH SPECIFICATIONS			900	2-4	3-6		65-75

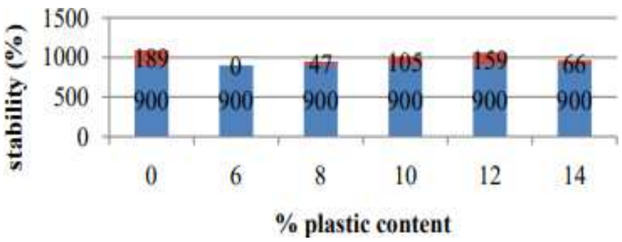

Figure.5 Variations of Plastic in bitumen and stability (KN)

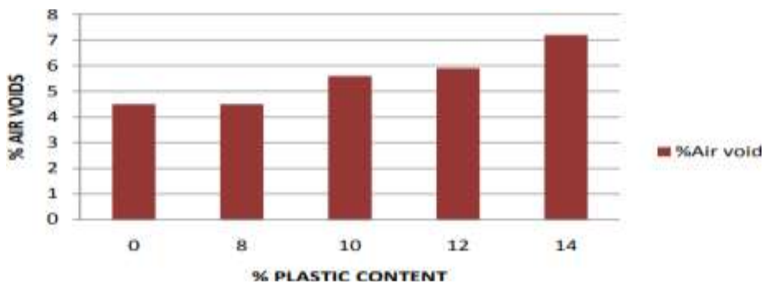

Figure.6 Variations of Air Voids (Va) and % of plastic

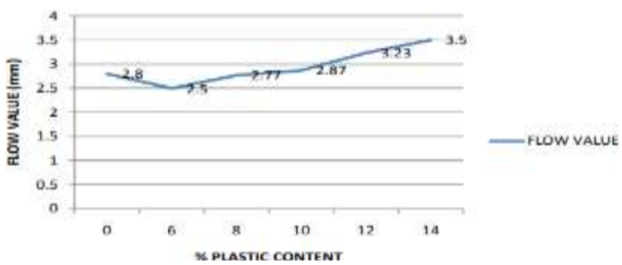

Figure.7 Variations of Flow value (mm) and % of bitumen content

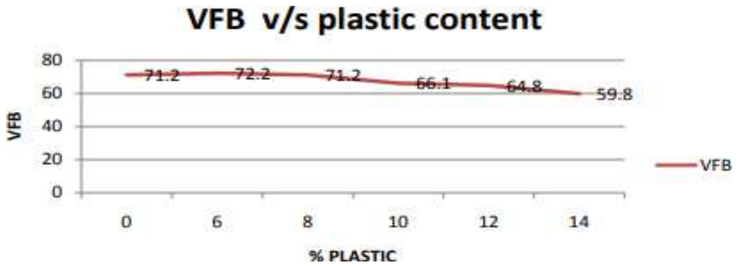

Figure.8 Variations of Voids filled with bitumen (VFB) and % plastic content

IV. CONCLUSION

The use of innovative technology not only strengthens the road construction but also increased the road life as well as will help to improve environment and will also create source of income.

The plastic mixing also reduces the voids. This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reducing rutting, raveling and there is no pothole formation. The roads can withstand heavy traffic and show better durability.

In short we can conclude that, using plastic waste in mix will help reduction in need of bitumen by around 10%, increase the strength and performance of road, avoid use of anti-stripping agent, avoid disposal of plastic waste by incineration and land filling and ultimately develop a technology, which is eco-friendly. Increased traffic conditions will and are reducing the life span of roads. Plastic roads are means of prevention and ultimately will be the cure. It will save millions of dollars in future and reduce the amount of resources used for construction.

- Utilization of waste plastic improves the binding property of mix.
- The optimum results of waste plastic come out to be 8% from the experiments conducted.
- The properties of bitumen such as penetration, softening point improved with the addition of the waste fiber.
- Plastic roads can also be constructed in the areas having temperatures (50ºC).
- Waste plastic *in roads increases the stability value and durability to a great extent*

FUTURE SCOPE

Many properties of BC mixes such as Marshall Properties drain down characteristics, static tensile strength, and static creep characteristics have been studied in this investigation by using only VG 30 penetration grade bitumen and polyethylene. However, some of the properties such as fatigue properties, resistance to rutting, dynamic indirect tensile strength characteristics and dynamic creep behavior needed to be investigated.

- In present study polyethylene is added to them mix in dry mixing process. Polyethylene can also be used for bitumen modification by wet mixing process and comparisons made.
- Microstructure of modified bituminous mixture should be observed by using appropriate technique to ascertain the degree of homogeneity.
- Combination of paving mixes formed with other types of plastic wastes which are largely available, wastes to replace conventional fine aggregates and filler an different types of binders including modified binders, should be tried to explore enough scope of finding suitable materials for paving mixes in the event of present demanding situations.

REFERENCES

1. Raja sekaran, S., Vasudevan, R. and Paul raj, S. (2013) Reuse of Waste Plastics Coated Aggregates-Bitumen Mix Composite for Road Application—Green Method. American Journal of Engineering and Research, 2, 1-13.
2. Justo, C.E.G. and Veeraragavan, A. (2002) Utilization of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads. Banglore University, Bengaluru.
3. Swami, V., et al. (2012) Use of Waste Plastic in Construction of Bituminous Roads. International Journal of Engineering Science and Technology (IJEST), 4, 2351-2355.
4. Punith, V.S (2010) Study of the Effect of Plastic Modifier on Bituminous Mix Properties.
5. Bale, A.S. (2011) Potential Reuse of Plastic Waste in Road Construction: A Review. International Journal of Advances in Engineering & Technology (IJAET), 2, 233-236.
6. Vasudevan, R., Nigam, S.K., Velkennedy, R., Ramalinga, A., Sekar, C. And Sundarakannan, B. (2007) Utilization of Waste Polymers for Flexible Pavement and Easy Disposal of Waste Polymers. Proceedings of the International Conference on Sustainable Solid Waste Management, Chennai, 5-7 September 2007, 105-111.
7. Gawande, A., Zamre, G.S., Renge, V.C., Bharsakalea, G.R. and Tayde, S. (2012) Utilization of Waste Plastic in Asphalting of Roads. Scientific Reviews & Chemical Communications, 2, 147-157.
8. Jose Ramon Jimenez. (2011). “Utilisation of unbound recycled aggregates from selected CDW in unpaved rural roads”, Resources, Conservation and Recycling, Vol. 58, Construction Engineering Area, University of Córdoba, Córdoba, Spain, pp 88– 97.
9. Sangita. (2011). “Effect of waste polymer modifier on the properties of bituminous concrete mixes”, Construction and Building Materials, Vol. 25, Central Road Research Institute, New Delhi, India, pp 3841–3848.
10. Babu K. K. and Raji A. K., (2007) “Utilization of marginal materials as an ingredient in bituminous mixes”, Highway Research Record No. 36, Indian Roads Congress, pp. 42-43.
11. Bandopandhyay T. K., (2010), “Construction of Asphalt Road with Plastic Waste”, Indian Center for Plastic in Environment (ICPE), ENVIS - Eco-Echoes, Vol.11, Issue 1.