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Study Different Physical Properties of Asphalt Mix with Waste Plastic in Pavement Construction

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ABSTRACT:

The increasing population is inviting the increasing demand of various packaging materials. But more requirement the natural material availability and long time taken in way of processing synthetic materials are the option to fulfill the demand of natural material to control the cost and availability. The increasing use of synthetic material is one serious problem of dispose off, according to problem of material dumping it may use in flexible pavement construction. The length of Indian road network 6215797 km and plastic waste generation 3.3 MMT. The blending of common waste plastic avg 7% with 5.46 % charcoal and the strength parameter were found to be significantly.

Key words- basic specific gravity, stability

I-NTRODUCTION

The rapid urbanization and too provide better infrastructure to help the growth of bituminous road. The bituminous provided by Indian manufacture give the required number of characteristics but fail on ground performance. The premature failure in Indian road-flexible pavement is due to the inability to sustain cyclic wheel loads using conventional Asphalt. The increase in demand for Asphalt and unavailability of good quality Asphalt by various indigenous sources had reduced its consumption. To boost its performance by increasing its durability and by reducing its maintenance and renewal cost will give a spike in its use. The Asphalt is the material that provides the surface performance of the road constructed by it. To add such properties in Asphalt to improve surfacing, it needed to add some polymers, rubber or sulphur, etc.

Plastics had occupied an integral part in our day-to-day life due to their lightweight, easy availability, durability and energy efficiency. Hence, it had increased the use of plastic in daily needs and at the same rate as plastic waste generation. The plastic is reusable and recyclable. There should not be any consequence; however, this scenario is not present because of littering hobbits, and inadequate disposal management methods in civic society have caused a significant problem. Researchers need to use this waste in construction to eliminate these problems,

The various worldwide research and research have revealed that India's increase in properties of a pavement of Asphalt and bituminous by incorporating various additives will enhance its performance. This added substance is called Asphalt Modifier and the Asphalt blended in with this modifier is called Modified Asphalt. The performance of surfacing in modified Asphalt is 50 to 90 per cent due to the degree of modification as per additives. The requirement of polymer modification of Asphalt in construction to have durable pavement with stiffness and stability properties in cost reduction in maintenance. The consumption of virgin polymer can increase the construction cost in that to improve pavement; we need to use recycled polyethene “RPE” and crumb rubber (CR), which also help in reducing environmental waste (Zani, Giustozzi and Harvey, 2017) The benefits of Polymer Modified Asphalt, keeping the above the availability and increasing waste and their utilization the study is required.

2-Methodology

2.1 Asphalt Blend Preparation common plastic

In blend preparation, using a polymer as a modifier like scrub tiers using a mechanical blender are very much helpful as drawn in a literature review. It is also clear that time, temperature and shear force of blending are affecting factor of blending. For our research blending time of 40 minutes and higher shear stress to mix evenly in the waste plastic sample with a shorter blending time, no change in the rheology occurs(Leng *et al.*, 2018). The mechanical blending is used to have uniform missing as higher shear stress is required for HDPE.

2.2Mechanical Blending

The collected waste plastic of HDPE is reducing to a size of 4-5 mm. The electric heater of waste plastic and Asphalt in a separate container is set at 175℃ and 180℃, respectively. After both converted into a liquid, the stirrer in Asphalt is set to 1000 rpm and gradually, waste plastic is added. The speed of the stirrer is increased to 1500 rpm to provide sufficient shear stress for 40 minutes. These steps create a homogeneous mixture of binder and collected into storage for experimental purposes and remaining to mix it with aggregate (Yao *et al.*, 2018). To increase the percentage of waste plastic required a longer time to blend. To study a mix of 4%, 6%, 8% and 10% is used.

2.3 Sample Preparation

The sample preparation is done majorly three parts and individual parts have to go through various testing processes. The process is studied in this research extensively are as follows:-

- → Selection of materials
- → Modified Asphalt (Asphalt and plastic)
- → Specimen Sample (Modified Asphalt and Aggregate)

2.4 Selection of materials

The selection of raw material and in this research helps to study characteristics of a Asphalt mix by reducing a substantial amount of the Asphalt by adding plastic. The adaptability of plastic in road construction is studied in Asphalt Macadam and Semi Dense Asphalt concrete (SDBC). The MORTH (2001) is used to gradation of fine and coarse aggregate (Adnan *et al*., 2018). The result of waste plastic is analyzed using various tests like the Fatigue test, Indirect Tensile Test and Marshall Test etc.

2. 4.1Asphalt

To prepare our sample 80/100- grade Asphalt used with a specific gravity of 1.025.

Table 1: "Physical properties of Asphalt."

S No.	Test	Test Result
1	Penetration	87
2	Softening Point (Ring and Ball Method) ℃	51
3	Ductility	96

2.4.2 Waste Plastic

The waste plastic is collected from the Saharsa district of Bihar. This is due to reduce the plastic waste in our society and one step forward in reducing already dumped waste. The collected sample has a specific gravity of 0.48.

3-Strength Parameter Testing

3.1 Retained Marshall Stability Test

To check water susceptibility of Asphalt mix- the Marshall test is performed on another specimen using optimize quantity by keeping in a water bath for 24 hrs at 60 ℃. Therefore the result obtained is the "Retained Marshall Stability Test".

3.2 Indirect Tensile Strength Test

In the Indirect Tensile Strength Test, the labelled sample kept for 24 hrs is then dipped into the water at 25℃ for the next 2 hours. However, then the compressive load is applied in the vertical direction of the plan. A sample size diameter plate is placed under 12.7 mm wide machine faceplate to have even force distribution. Therefore, this loading provides uniform tensile stress perpendicular to the applied load until it fails in the same direction and the equation gives it:-

$$S_T = \frac{2P}{\pi DT} \quad \textbf{(1)}$$

Where,

S_T = Tensile strength (Kg/ $cm^{2)}$

P = Total load at failure (Kg)

H = Height of specimen (cm)

D = Diameter of specimen (cm)

3.3 Fatigue Test

To determine the cyclic failure strength, a fatigue test is performed. "The test was conducted on a sample that is prepared 24 hours before using, the third point loading on a beam of 50 cm length, 10 cm width and 10 cm height in cross-section. The sample is fitted on the testing machine and 70 times per minute of "153 kg, 204 kg and 493 kg" of the cyclic load is applied at 15-20℃ till it fails (Karmakar and Roy, 2016).

3.4 Volumetric Analysis of Compacted Mixes:

The volumetric properties mix after the compactness such as specific gravity, density, mineral aggregate and air void are needed to be regulated as its impact on the performance of a designing condition.

3.5 Density

To determine the density, the dry weight and immersed displacement of sample and at 25 ± 1°, C is measured. And the other way is to multiply by a factor of 62.4 to a specific gravity of the specimen.

3.6 Specific Gravity

The Bulk Specific Gravity (BSG) of each type of material must be measured so that volumes can be computed from the weights as desired. "The BSGs of the individual coarse aggregate fractions, the fine aggregate and mineral filler fractions are used to calculate the Bulk Specific Gravity (G_{sb}) of the total aggregate" using the following formula:

$$G_{sb} = \frac{P_1 + P_2 + \cdots P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \cdots \frac{P_n}{G_n}} \quad \textbf{(2)}$$

Where,

G_{sb}= Bulk specific gravity for the total aggregate

P_1, P_2,……..Pn= Individual % weight of aggregate

G_1,G_2.....G_n= Individual BSG of aggregate

3.7 Effective Specific Gravity

The "Effective Specific Gravity of the aggregate" (G_{se}) considers all voids of the aggregate sample mixture. The equation gives this:-

$$G_{se} = \frac{100 - P_b}{\frac{P_s}{G_t} - \frac{P_b}{G_b}} \quad \textbf{(3)}$$

Where,

G_{se} = Effective specific gravity of aggregate

G_t = Maximum specific gravity of mixed materials (no air voids) and

$$G_t = \frac{100}{\frac{P_s}{G_{se}} - \frac{P_n}{G_n}} \quad \textbf{(4)}$$

Where,

P_s= Aggregate % of the total weight of a mixture

P_b= Asphalt % of the total weight of the mixture

G_b= Specific gravity of Asphalt

3.8 Asphalt Content of the Mixes

$$P_{be} = P_b - \frac{P_{ba} P_s}{100} \quad \textbf{(5)}$$

Where,

P_{be}= Effective Asphalt % of total eight of mixture

P_{ba}= Absorbed Asphalt % of the total weight of aggregate

3.9 Air Void

The air spaces Asphalt the coated aggregate of the paving mixture is known as an air void. It is an essential factor in pavement performance. Too much air voids in the paving mixture may cause stripping allowing water to stay in it. Air void of compacted mixes is determined using the following formula.

$$V_a = 100 \times (G_t - G_{mb})/G_t \quad \textbf{(6)}$$

Where,

V_a= Air void in compacted mixture % of the total volume

3.10 Void in the Mineral Aggregate

The gap between the intermolecular space of aggregate and modified Asphalt is known as Void in the Mineral Aggregate. This is calculated by:-

$$VMA = 100 - \frac{G_{mb} \times P_S}{G_{sb}} \quad \textbf{(7)}$$

Results

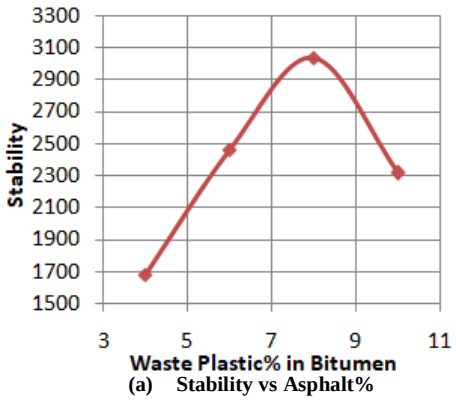
The various data analyzed and result tabulated in given table 1 and shown in various graphs

4 .1Asphalt Concrete (with Waste Plastic)

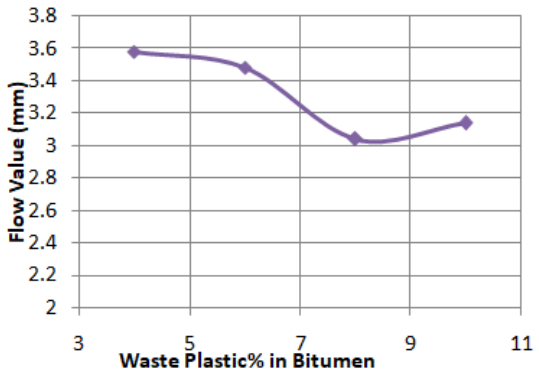
Table 2: Value of different Asphalt % (with plastic) in Semi Dense Asphalt Concrete

Asphalt %	Waste Plastic %	Stability (kg)	Flow (mm)	BSG of Mix (gm/cm^2)	Air Voids (%)	VMA %	VFB %
5.46	4	1495	3.58	2.28	5.45	17.58	69.03
5.46	6	2190	3.48	2.28	4.90	17.05	71.24
5.46	8	2640	3.04	2.29	3.74	13.98	76.58
5.46	10	2210	3.14	2.30	2.82	15.13	81.34

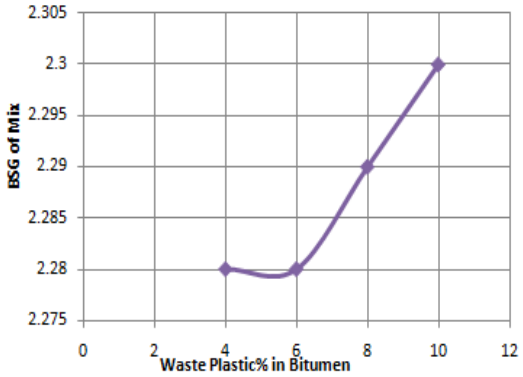
The result is drawn in the following Graphs:-



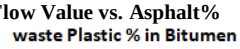
(a) Stability vs Asphalt%



(b) Flow Value vs. Asphalt%



(c) BSG vs. Asphalt%



(d) Air voids% vs. Asphalt%

(e) VFB% vs. Asphalt%

Graph 1: The graph showing (a) Stability, (b) flow value, (c) BSG of a mix, (d) air void % and (e) VFB% corresponding to waste plastic % in Dense Asphalt Concrete.

Conclusions

The present study was concluded according to the result obtained. The rate of blending common waste plastic with fixed quantity of Asphalt. The blending plastic quantity varies 4to 10 at an increment of 2% however the amount of b Asphalt was constant per cent age. As per table no 1 the different strength property increasing with increase of blend per- cent age of plastics. The stability is increasing 1495-2640 kg with increase of plastic blend up to 4- 8 % and strength is decreasing at 10 % plastic blending that was found to be 2210 kg. However; the basic specific gravity and Voids filled with asphalt percent are increasing and flow air void and percent of bulk volume are decreasing 3.58- 3.04, 5.45-3.74, 17.58-13.98 respectively. As per result the blending may be useful to reduce the plastic waste.

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