ISSN : 2321-9602

Indo-American Journal of Agricultural and Veterinary Sciences




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iajavs.editor@gmail.com

Indo-Am. J. Agric. & Vet. Sci., 2022 *ISSN 2321–9602 www.iajavs.com*

Indo-American Journal of Agricultural and Veterinary Sciences

Vol. 10, Issuse 2, Junel 2022

STUDY ON USE OF WASTE POLYTHENE BITUMINOUS PAVEMENT MIXES

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Abstract: Use of waste material in road construction is becoming more popular as a way to reduce the environmental effect of building roads across the world. These materials and technologies have been developed in the highway infrastructure to determine their appropriateness for the design, building and maintenance of pavements. One of these is polythene. Also taking into account the environmental element, the damage to the environment is huge as more and more polythenes is used in everyday operations. Carry bags and food coverings made of polythene are becoming more and more commonplace. Main emphasis of this research is to utilise the plentiful waste poylthene that may be used cheaply and easily. The use of polythene in the sub-base course of the pavement will provide strength and is environmentally good when these waste materials are used in road building. Bitumen and tar are both bituminous binders used in pavement construction. Hydrocarbon substance derived from the fractional distillation of crude oil known as bitumen is accessible. Bituminous materials are often utilised in highway building because of their ability to bind and seal off water. Plastic has become the best buddy of the average guy. It may be used in any industry. Packaging accounts for almost half of all plastic waste. Carry bags, cups, thermopolis, and foams are the most common plastic packaging materials. Polymers such as polyethylene, polypropylene, and polystyrene are used in the production of these products. Polyvinyl chloride (PVC) tubing and wires are used. Thrown away or discarded, these items end up in landfills or combined with municipal solid waste (MSW). The non-biodegradability of plastic means that it is difficult to dispose of and generates societal issues that contribute to environmental degradation. One of the most pressing issues facing modern civilization is the pollution created mostly by plastics. Bituminous mixtures containing 'Zycothermal', a chemical stabiliser, may be made by substituting 8 percent, 10 percent, and 12 percent of bitumen by weight of plastic for optimal bitumen content. Straight run bituminous mix is compared for stability and flow.

I. INTRODUCTION

Paving sector bituminous binders offer a wide range of civil engineering uses. The pavement is made up of many layers. Aggregate and bitumen are the primary ingredients of a bituminous concrete (BC) mix. Generally speaking, all hard-surfaced pavements fall into two categories: Flexible and Rigid. A thoroughfare

A healthy and stable economy relies on well-maintained infrastructure. Since independence, India's road system has grown significantly, connecting the country's many regions and states.

There are several types of plastic and their trash.

Polyethylene Terephthalate (PET) and Polyethene (PE) are the two most common

polymers (PET). Bottles often used to package drinks and drinking water are a major source of it. India generates around 40 million tonnes of solid trash, of which 12.3% is plastic, largely in the form of water bottles, which are thrown away. It is possible to classify them as either thermoplastics or thermosettings depending on their physical qualities. When heated and cooled, thermoplastic materials may be moulded into any desired shape. They may be reshaped by using the same heat and pressure as before.

The properties of a plastic-bitumen mixture

Compared to asphalt, certain fibres have a high level of tensile strength. It was discovered that fibres may increase the cohesiveness and tensile strength of bituminous mixtures in this study. Asphalt mixes are thought to undergo physical changes as a result of them. Plastic may efficiently improve the mechanics of asphalt concrete, increase the asphalt concrete's compressive and tensile strength, and extend the pavement's fatigue life. Incorporating plastics into asphalt is considered to improve the material's strength and fatigue resistance.

Aims and Objectives

Stability, less air spaces, and reduced flow are all predicted benefits of using plastic. Adding plastic to the bituminous mixtures will also improve their flexibility. As a result, bituminous mix contains varying quantities of plastic [1-2].

Objectives

The purpose of this research is to examine the impact of plastic on the strength properties of bituminous plastic blends. The goals of this research are:

- To investigate the stability, flow, and volumetric features of plastic-blended bituminous mixtures.
- To ensure that the plastic content in plastic-blended bituminous mixtures is at an optimal level.
- To study the cost effectiveness of plastic blended bituminous mixes.

II. **LITERATURE REVIEW**

III. An experiment conducted by Tapkin, (2008) found that the addition of fibre to bitumen resulted in stiffer mixes with less binder run off. When compared to the control mix, the fiber-modified mixes had better Marshall Properties, including higher bulk specific gravity and greater stability. Increasing rutting resistance with the use of fibres may increase fatigue life and deformation properties. We noticed an increase in the tensile strength and other attributes of fiber-based mixes. The optimal binder level of fibre-based combinations was somewhat higher than that of the control mix. The inclusion of ultra-fine aggregates is comparable to this. In order to coat the fibres, the required amount of bitumen is dependent on the absorption and surface area of the fibres, as well as the concentration of the fibres (Button and Lytton, 1987). According to Mills and Keller (1982), the strength of the resultant mixes is determined by the degree of homogeneity with which the fibres are dispersed throughout the mix. According to the field research, fibres may assist to develop more flexible mixes that are less prone to cracking, therefore making them easier to work with (Jiang et al., 1993). Bituminous mixture design approaches include the well-known Marshall and Superpave techniques. Both the Marshall and Superpave mixture design techniques use volumetric parameters (specific gravity, air void, etc.) to establish the engineering properties of the mixture, and bitumen content is an important factor in this process. Fiber-reinforced bitumen has different volumetric characteristics than conventional bituminous mixture (Serfass and Samanos, 1996). The volumetric features of these combinations must be studied in order to create more trustworthy ones. The volumetric and technical characteristics of bituminous mixtures are influenced by the amount of fibre in the mixture [3-10].BITUMINOUS MIX DESIGN

The results of polls reveal which route people favour. A traffic study and profile levelling were completed. sampling from trenches near to the current road.

What are the goals of the current topics?

To compare the PCA's characteristics to those of traditional aggregates in order to draw conclusions.

In order to get plastic coated aggregates for Bituminous Concrete Mix (Dry Technique) using the Marshal method of mix design and compare it to traditional Bituminous Concrete Mix, the optimal bitumen concentration (OBC) of Bituminous Concrete Mix was determined, as was the optimum plastic content (OPC).

For the purpose of determining the Marshal stability of a bituminous concrete (BC) mix using the Marshal technique of mix design.

Methods and materials

The following are the components utilised.

• AggregateThis is a bituminous glue.

There are two types of minerals:

• Recycled plastic (LDPE)

For the necessary testing, we used conventional aggregates and PCA aggregates that had the requisite strengths, toughness, specific gravity, and shape. Aggregate gradation that meets IRC 111-2009 grading-1 parameters was chosen. Figure-1 shows that the chosen aggregate gradation for hot asphalt mix design is within the stipulated range.Table Properties of 6mm aggregates

Table : Properties of 10 mm aggregate

Mineral Filler:

Description of the Test	Test result	Requirement as per MORTH specification (TABLE 500-14)
Aggregate Impact Value (%)	6.43	Max 27
Combined Elongation and Flakiness Indices(%)	20%	Max 30
Water absorption (%)	0.5	Max 2%
Los Angeles Abrasion Test	22	30%
Specific gravity(g/cc)	2.65	-

Rock dust, hydrated lime, or cement may all be used as filler since they are finely separated minerals. Hydrated lime has excellent anti-stripping and anti-oxidant qualities, making it an ideal choice for cleaning. Addition of this material to the hot mix asphalt increases its density and improves its tensile strength. Table-I below shows the filler gradation.

Table-I: Grading requirement of Mineral filler

IS sieve size in mm	Cumulative % by weight of total aggregate passing
0.6	100
0.3	95-100
0.075	85-100

Bitumen: The bitumen used in the experiment was 80/100 grade and was tested in the laboratory for basic tests, penetration, ductility, softening point, specific gravity and viscosity.

Table : Properties of bitumen

Description of the Test	Test result	Requirement as per MORTH specification
Penetration Test(mm)	69	65
Specific gravity(g/cc)	1.02	Min 0.99
Softening point (°C)	51	45 to 55
Ductility test (mm)	>100	Min 75
Flash point(°C)	175° C	-
Fire point(°C)	180°C	-

Modifiers (Plastic waste): The processed waste plastic bags (LDPE) from the garbage of local area in the shredded form was used as additive. The shredded waste plastic was cut into pieces of uniform size passing through 2.36 mm IS sieve and retained on 600 µ IS sieve. Thickness between 10 µ to 30 µ.

Table-II: Properties of Waste Plastic

Property	Values
Size (Range)	2.36 mm - 600 µ
Density (gm/cc)	0.95
Melting Temperature in °C	130- 160

Marshall Mix design: Plastic garbage was shredded and mixed with the aggregate at a temperature of 140 to 175 degrees Fahrenheit for this study's experiments. The heated aggregates are originally covered with the waste plastic. A modified bituminous concrete mix was made by mixing plastic coated aggregate with hot bitumen for 15 seconds and then adding the mixture to the aggregates. Bitumen was added based on the weight of the mixture, and plastics were added in varying proportions based on the bitumen weight.

Design of Bituminous Concrete mix: Bitumen was added to the mix in various ratios (6 percent, 8 percent, 10 percent, 12 percent, 14 percent, and 16 percent) based on weight, and plastic was added in the same proportions (14 percent) as bitumen. The specified tests were carried out on the Marshall samples, which were made from traditional and plastic modified bituminous mixtures. After 24 hours at 60°C, the Marshall specimens are known as "conditioned specimens," whereas the specimens held at 60°C for 30 to 40 minutes in a thermostatically controlled water bath are known as "unconditioned specimens." The volumetric parameters of each blend were plotted versus the bitumen content. By averaging bitumen content values for maximum stability, maximum density, and 4% air gaps, the OBC for each blend could be determined..

IV. RESULTS AND DISCUSSION

As a result of applying Marshall method of mix design to semi-dense bituminous concrete, this chapter presents results for a reference mix and a plastic-blended bituminous mix in terms of properties such as stability, flow, air voids (VVs), voids in mineral aggregate (VMAs), bitumen-filled voids (VFBs), unit weight and bulk specific gravity. The Marshall technique is also used to calculate the Optimal Plastic Content.

Plastic-free bituminous mix (reference mix)

Reference specimens were those made without the use of plastic. Marshall specimens were prepared with a binder level of 5% (by weight of the mix). This binder content was used to create three specimens for the lab tests. Tested in accordance with ASTM D1559. In order to determine the mix's stability, flow, air voids, voids in mineral aggregate (VMA), and voids filled with bitumen (VFB), unit weight and bulk

specific gravity, the parameters of the mixture were analysed.

Table-III: Properties of bituminous mix without plastic

Bitumen Content (%)	Stability (Kg)	Flow (mm)	Unit Weight (gm/cc)	Air Voids (%)	VMA (%)	VFB (%)
5	2812.5	2.1	2.41	3.45	15.30	77.39
	2718.75	2	2.42	2.98	14.87	79.94
	2406.25	2.6	2.43	2.73	14.65	81.30

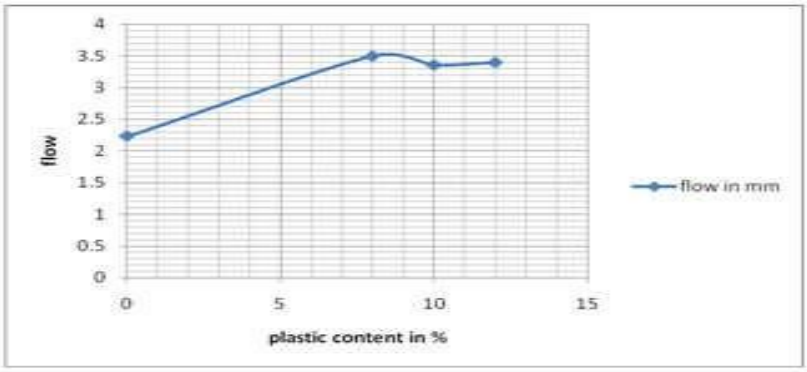
Table-IV: Properties of plastic blended bituminous mix

Binder content (%)	Plastic content (%)	Stability (KN)	Flow (mm)	Air Voids (%)	VMA (%)	VFB (%)	Unit Density (gm/cc)
5	8	2718.5	2.2	2.86	14.76	80.62	2.42
		3218.75	4	3.26	15.11	78.40	2.41
		3634.38	4.3	4.61	16.30	71.68	2.38
	10	2000	3	3.06	14.94	79.49	2.42
		3062.5	4.4	5.61	17.18	67.32	2.35
		2443.75	2.7	4.62	16.31	71.65	2.38
	12	2000	3.5	5.29	16.90	68.67	2.36
		2968.75	3.4	4.27	16.00	73.28	2.39
		2156.25	3.4	5.44	17.03	68.01	2.36

Bituminous mix with plastic

Plastic was used to prepare the specimens for testing. Marshall Specimens were prepared with binder concentration of 5% (by weight of specimen). Bitumen was used to increase the plastic content from 8 percent to 12 percent of the bitumen's weight. Each plastic content has three specimens made. ASTM D 1559 was used to evaluate nine samples. In the table, stability, flow, air voids, Voids in mineral aggregate, and voids filled with bitumen were calculated after the pre-test observation.Stability Property of Plastic blended bituminous mix

The behavior of stability property by varying the plastic content is shown in figure.



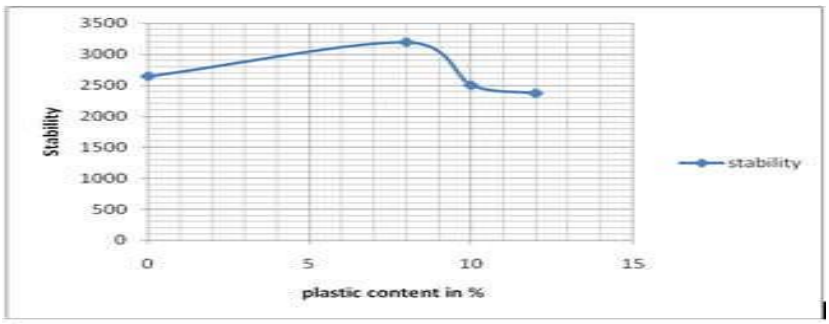


Fig.: Stability Property of Plastic blended bituminous mix

Flow Property Of Plastic Blended Bituminous Mix

The behaviour of flow properties by varying the fibre content is shown in figure .

Figure: Flow Property of Plastic blended bituminous mix

The flow value was first seen to decrease as the amount of plastic in the mixture increased. This is because the frictional barrier to deformation is increased by the addition of plastic. Because of this, the flow rate rose as the plastic component in the mixture became larger, resulting in less aggregate-to-aggregate contact.

A Plastic-Bituminous Mixture's Volumetric Characteristics

Figure illustrates the effect of altering the plastic content on Volumetric Properties. The unit weight of the plastic-blend bituminous mix is determined, as are the volumetric parameters such as air voids (VV), voids in mineral aggregate (VMA), voids filled with bitumen (VFB), etc

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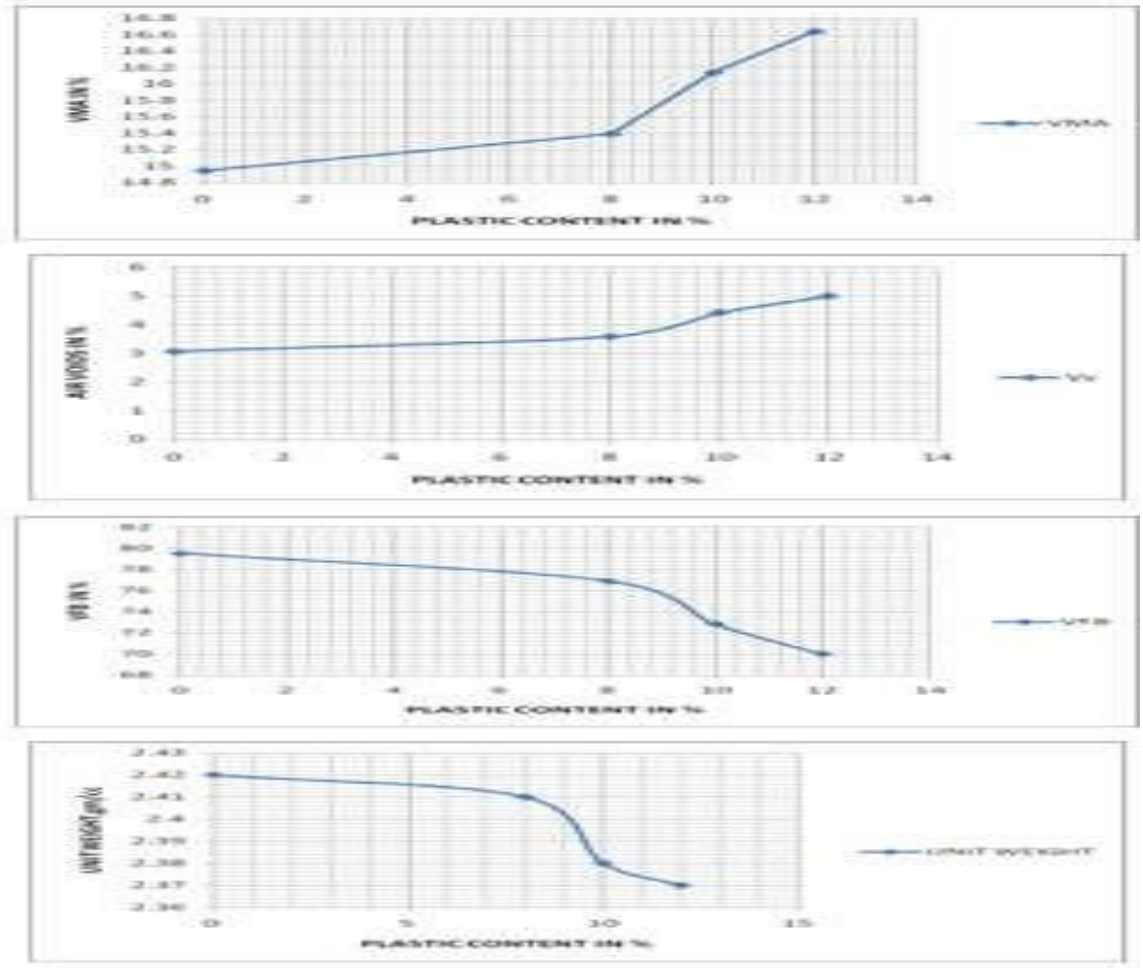

Figure: Volumetric Properties of Plastic blended bituminous mix

As plastic content rises, so do the air gaps and voids in mineral aggregate, whereas the bitumen-filled voids and their unit weight fall. There were gaps between the aggregates as a result of the plastic filling in the spaces. The greater the plastic concentration in a mixture, the less compact it was projected to be, resulting in larger air void values. The unit weight reduces as the number of vacancies rises.

CONSTRUCTION OF THE BEST PLASTIC CONTENT IN THE BITUMINOUS MIXTURE

The ideal plastic concentration was determined by taking the average of all binder, which correlates to greatest stability and unit weight, lowest flow, mean air voids, mean VFB, and mean VMA, respectively. ' According to the graph, the ideal level of plastic content stability was determined, as well as the flow of air voids (VFB, VMA, unit weight, and binder content). The

Table 1 displays the attributes and optimal plastic content for various materials.

COMPARISON OF THE PROPERTIES OF REFERENCE MIX AND PLASTIC BLENDED BITUMINOUS MIX

The properties and the optimum values of plastic blended bituminous mix were compared with the properties of reference bituminous mix by varying the plastic content. The mean values of stability, flow, air voids, Voids in mineral aggregate, voids filled with bitumen and unit weight of plastic blended bituminous mix were compared with the properties of reference bituminous mix by varying in plastic content.

Table: Comparison Of The Reference Mix With Plastic Blended Bituminous Mix.

Optimum percentage and Properties	Without plastic	With plastic	Percentage variation (%)
Optimum plastic content (%)	0	8.6	-
Stability Kg	2645.833	3190.625	+20
Flow mm	2.23	3.5	+0.57
Air voids (%)	3.06	4.36	+42.48
Voids in mineral aggregate (%)	14.94	16.05	+7.43
Voids filled with bitumen (%)	79.54	73.23	-7.93
Unit weight (gm/cc)	2.42	2.39	-1.24

V. CONCLUSIONS

Using data from a research and experiments, the following conclusions can be drawn about the waste plastic modified bituminous concrete mix and the regular bituminous concrete mix:

findings revealed that waste plastic may be utilised as a bituminous concrete mix modifier because it is applied to aggregate and coat the aggregates to decrease porosity, absorb moisture and enhance bonding properties. The OBC (Optimum Bitumen Content) was determined to be 5.43 percent of aggregate weight. This mix's Optimum Plastic Content (OPC) was determined to be 9.73 percent weight of the bituminous concrete mix's Optimum Bitumen Content (OBC). There were significant differences in Marshall stability (about 21 percent) and flow value between the bituminous concrete mix modified with waste plastic-coated particles and normal bituminous concrete mix.

Up to a plastic content of 12 percent, the Marshall stability value rises, but beyond that, it falls. It's not ideal to rely on a bigger proportion of waste plastic/polythene. Despite the higher rigidity, the adjusted mix remained within the established tolerances.

For both MORTH and IRC:111-2009, the volumetric and Marshall characteristics of standard and modified bituminous concrete mixes were almost in accordance with the requirements. This demonstrates that a bituminous concrete mix including plastic waste is superior and better suited for the building of flexible pavements.

Even under the most extreme moisture conditions, the plastic waste modified mix is resistant to stripping. The thin plastic coating applied to plastic coated aggregates (PCA) increased physical qualities such as Aggregate Impact Value, Los Angles Abrasion Value, Water Absorption Value, and soundness, among others, significantly when compared to traditional aggregates (without plastic coating).

To save money, the plastic waste modified mix (OPC= 9.73 percent by weight of OBC) uses less bitumen. This means that building plastic roads will cost less. The Dry Method may also be used to make the relatively weak stone aggregates stronger by coating them with a suitable plastic.

At 8% plastic, bituminous mixes become more stable and flowable, enhancing their characteristics. The flow and stability of the product reduced when the plastic component was increased to 12 percent. As a result, an 8 percent plastic content is the ideal. Due to traffic pressures on flexible road pavements, the semi-dense bituminous concrete may increase structural resistance to damage.

As the percentage of plastic increases, so do the voids. In warmer places where the bituminous mix is prone to bleeding, the voids grow significantly. By increasing the number of voids, you give the binder more room to move about and keep it from rising to the surface.

According to the findings, adding plastic to a bituminous mix greatly improves the bituminous layers' tensile stress resistance. As a result, this strategy is crucial.

uses plastic as an alternative to provide a remedy to an environmental issue that has become a big one. Increasing the road's strength is more important to them than anything else. With the use of such cutting-edge technology, society may become more resilient, healthy, and environmentally friendly.

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