A STUDY ON USE OF POLYMERIC WASTE MATERIAL IN BITUMEN FOR ROAD PAVEMENT

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Abstract: Since bitumen is the vital component in all over the world for making flexible pavements. It is having asphalt or bitumen with mineral aggregates and are mixed together, layed in adjacent layers and finally compacted dense. If the bituminous pavement is designed and paved in ideal conditions, it proves satisfactory but we can never meet such ideal conditions on site as the circumstances vary from region to region and time to time. Thus these unfavorable conditions make these pavements poor in performance. Also due to continuous increase in traffic, modern pavement needs to be enough durable under load and traffic volume.

Researchers have from time to time tried their hand in reducing these flaws in bitumen paved roads. Some of the ways proved beneficial. One such effort includes adding waste polymeric units to bitumen under well designed procedure. Now plastics is another severe threat to the environment. It can degrade environment quality.

Because this thing is non-biodegradable it damages soil properties, adds many unwanted gasses to air if burnt in open air. Incorporating this waste polymeric unit in bitumen can benefit us in both ways by reducing pollutant in environment and also adding to properties of asphalt under drastic conditions.

In this research we have used low density polythene(LDPE) in form of packets used in packing of various brands of milk. In dry form with aggregate. In this research detailed study is carried to check engineering properties of bituminous concrete. optimum binder content and optimum polythene content is derived using Marshall procedure. The OPC has been found 4%. At this percentage marshal stability value is maximum and marshal flow value is minimum.

Index Terms: Bitumen, Waste Plastics, Aggregates, Marshal Stability Value, Marshal Flow Value, VMA, VFB, Aggregate Density Value.

Introduction:

Since the threat of plastic is immense threat to the environment and its disposal becomes mandatory at ground level. Firm practical steps are needed to be taken towards elimination of this menace. The possibility of improving performance of bitumen mix used in surfacing of roads is there with the use of this Plastic waste. Studies show reduction in deformations of surface rutting and diminishing low-temperature cracking with the use of re-cycled plastics mainly polyethylene manufactures. The field tests show enhance in the life of roads due to use of these processed plastic wastes and hence with stands stress and also solves environmental pollution issues. Being versatile product, plastic usage occupied every aspect of our day to day life. By industrial revolution plastics became cheap and very essential raw material and its production increased rapidly. Every sector of economical function, from agrarian works to industrial packing to building construction to automation and communication sector has accepted plastics as basic material for packing goods. Researchers have found that plastics can remain on earth for thousands of years without degradation and decomposition. Many researchers found that waste plastics when mixed to hot aggregates make a lamination around them and when these are mixed with binder yields in higher strength, resists to water penetration and gives better performance to these concretes.

It is not new to use to use polyethylene in road construction. Some aggregates are hydrophilic. But bitumen polyethylene is water hating in nature. So adding polymers which are hydrophobic polymers in wet or dry mixing to asphalt leads to increasing water repelling capacity and increases strength. Polyethylene gets mixed to hot bitumen and mixture is laid on pavement surfaces like ordinary tar road. The disposable cups, carrying bags PET bottles polyethylene packets collected from waste garbage as important construction component are mainly used in plastic roads. Modification with polymers can improvise rutting, fatigue life, thermal cracking etc in pavements. Modified bituminous mixture created by

reusing polyethylene polymer adds to properties of HMA. Not only it adds to strength and durability but proves beneficial in reducing environmental pollution by recycling waste plastics.

Literature Review:

Understanding the effect of waste polythene in Bitumen pavements, its mandatory to go through previous work data base. The research data consulted in compiling this thesis is as under;

Adou et al (2018): In this research, wastes of plastics were collected and coated around aggregates and added to bitumen after proper processing to form asphalt containing plastic wastes and specimens were taken to laboratory for various tests to determine properties. The experimentation results show that the quality and properties of aggregates was enhanced

Bajpai et al. (2017): experiments were conducted if waste plastics prove beneficial for road construction in a productive way. At several institutes experimental works show that waste plastics if added to hot aggregates forms a fine coat of plastics on aggregate particles and when these aggregates added to binder yields higher strength, better performance and high resistance to water penetration in pavements. Hence the proposal of using plastic wastes in road construction seems to be O.K

Ahmad et al. (2017): this research uses polyethylene tetra phthalate (PET) and provides its summary in use of roads. The data base from this research shows that PET improves characteristics of modified mix of asphalt. From the point of view of economy and environment PET used in asphalt mix is better and suitable way-out.

Chandu et al. (2016): . In this research work plastic wastes are thoroughly studied and also its coating over aggregates is studied with great effort.

Nanda kumar S and Mallikarjuna Hiremath (2016): this research uses low density polythene (milk pockets) to coat aggregates in bitumen mixture and all the characteristics like stability, air voids, density are checked. Comparison of optimum mix of bitumen with conventional mix is done. Softening point of such plastics is 1100- 1400 degree centigrade and hardly produce any toxic gas during heating but this plastic form forms thin coat on aggregate surface when sprayed on hot aggregate with temperature of 1600 degrees. Aggregates coated with plastic showed enhanced properties in binding and stability.

Brajesh Mishra and Ravi Shankar Mishra (2015): In this research Marchels method of designing was used to prepare 80/100 grade bitumen to get optimum content of bitumen. Samples prepared at bitumen content of 4% to 6% with increases of 0.5% by aggregate weight and keeping waste plastics at content of 0%, 6%, 8%, 10%, 12%, 14%, and 16%. As per optimum bitumen content, Flow value, marshal stability, air voids, marshal quotient, voids of minerals, filled voids by bitumen and stripping value were found and compared with physical properties of conventional concrete.

Prasad. B et al. (2013): in this research used bitumen and plastics rather than disposing them. With this ground water pollution and soil degradation is reduced. Thus addition of waste plastics to reused bitumen shows increased binding property, stability and resistance to water penetration.

Methodology:

Materials used: the coarse aggregates used in this research are used as per MORTH specifications as under;

Table 3.1: Gradation of Aggregates

SIEVE SIZE	% RETAINED
26.5mm	---
19mm	5
9.5mm	25
4.75mm	20
2.36mm	15
300µ	23
75µ	7
Filler	5

Specific gravity of Coarse aggregate was found 2.7 Also fine aggregates with specific gravity 2.6 and locally procured was used. The Bitumen used in this research work was having grade 80/100 and specific gravity equal to 1.02. Fly ash was used as filler with specific gravity of 2.2. Finally, the polythene in the form of milk packets was used as additive in this research.

Preparation of Marshall Samples: the mixing of ingredients is done as per following procedure (STP 204-8);

1. Required quantities of Coarse aggregates, fine aggregates & mineral fillers is taken into a pan
2. These materials were kept in an oven at temperature of 160°C for two hours for pre heating for mixing.
3. Bitumen is heated to its melting point before mixing
4. Polythene was weighed and kept in separate container.
5. The aggregates are heated on stove to maintain the pre mixing temperature
6. The shredded polythene is mixed with aggregates for about 2 minutes for homogeneity.
7. Now the bitumen (60gms) nearly 5% is added to mix and is stirred uniformly and homogeneously and the process is continued for about 20 minutes' till mixed properly.
8. Then mixes are transferred to casting moulds
9. The whole mix in moulds was compacted with Marshall hammer of weight 4.535 kg and diameter of 101.2 mm. the drop of hammer is maintained at 457mm height
10. 75 number of blows are given on each of sides of sample with counts to 150 blows for each sample
11. Then samples with moulds attached are marked and separated.

Results and Discussions:

1: Marshall Stability Value: maximum value at which the specimen fails under application of vertical load is called Marshall stability value. It is the maximum load supported by specimen at applying rate of load of 50.8mm/min. in this research load was increased until reached maximum and then load just begin to reduce and the load was recorded by proving ring. In this paper we have observed maximum Marshall stability value at polythene content of 4%.

2: Marshall Flow Value: it's the deformation of specimen at maximum loading at which failure occurs the plastic flow is measured by dial gauge attached to sample at loadings. Values from dial gauge are recorded in 0.25mm increments. Two recordings are taken from dial gauge, initial reading and final reading.

$$F = F - I$$

The other parameters which are checked are volumetric parameters like voids in Mineral aggregates (VMA), air voids (VA), voids filled with Bitumen (VFB). The formulas of these parameters are;

$$VMA = \left[1 - G_{mb} \times P_s / Gsb\right] 100 \qquad 1$$

$$VA = \left[1 - G_{mb}/G_{mm}\right] 100 \qquad 2$$

$$VFB = \left[(VMA-VA)/VMA\right] 100 \qquad 3$$

The table for graph plotting is as under. We will plot graph of all mean readings taken from the experimentation as under;

Table 3.2 Data for Graph Plotting

Polythene Content (%)	Unit weight (G_{mb})	MeanVMA (%)	Mean VA (%)	Mean VFB (%)	Mean S (KN)	Mean F (mm)
P0	2.312	16.309	4.976	69.501	13.34	3.766
P1	2.509	17.245	3.870	77.571	13.28	3.833
P2	2.281	18.447	3.096	83.280	13.55	3.400
P3	2.249	20.112	2.580	85.492	14.53	3.300
P4	2.208	22.087	3.170	85.639	16.71	3.400
P5	2.179	23.625	2.946	87.528	14.93	3.400

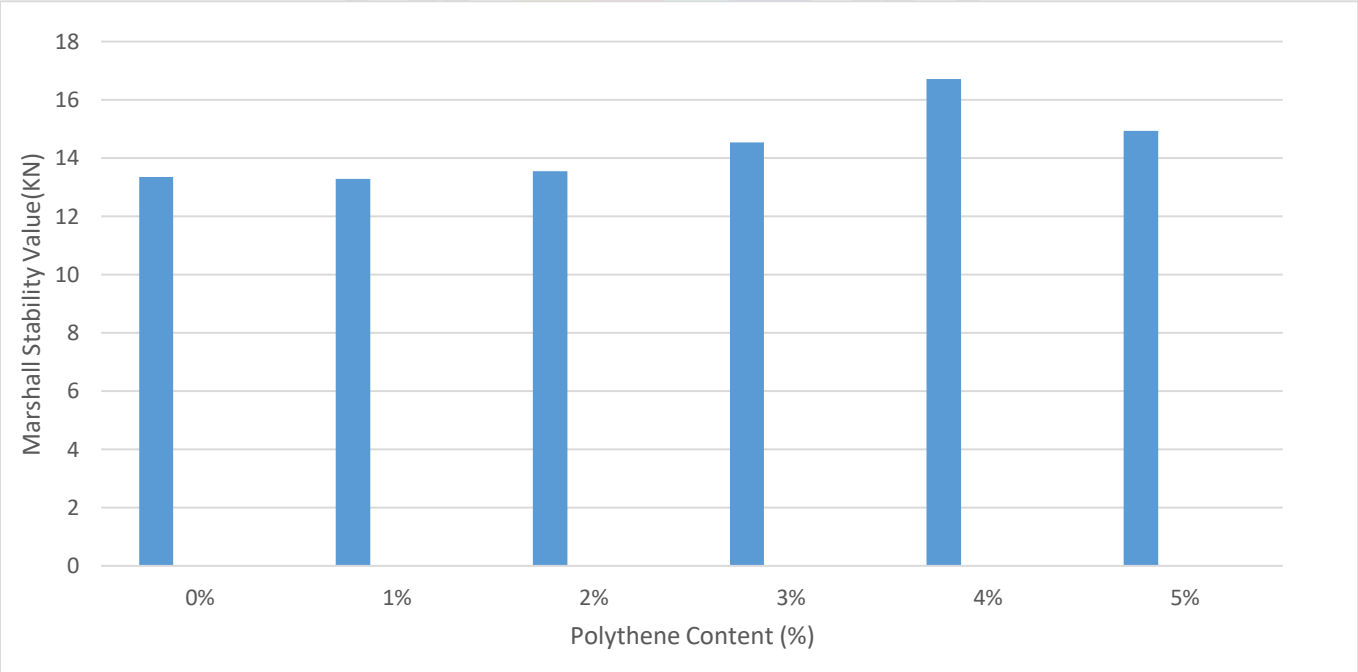

Fig 1.1: Marshall Stability Value vs. Polythene Content

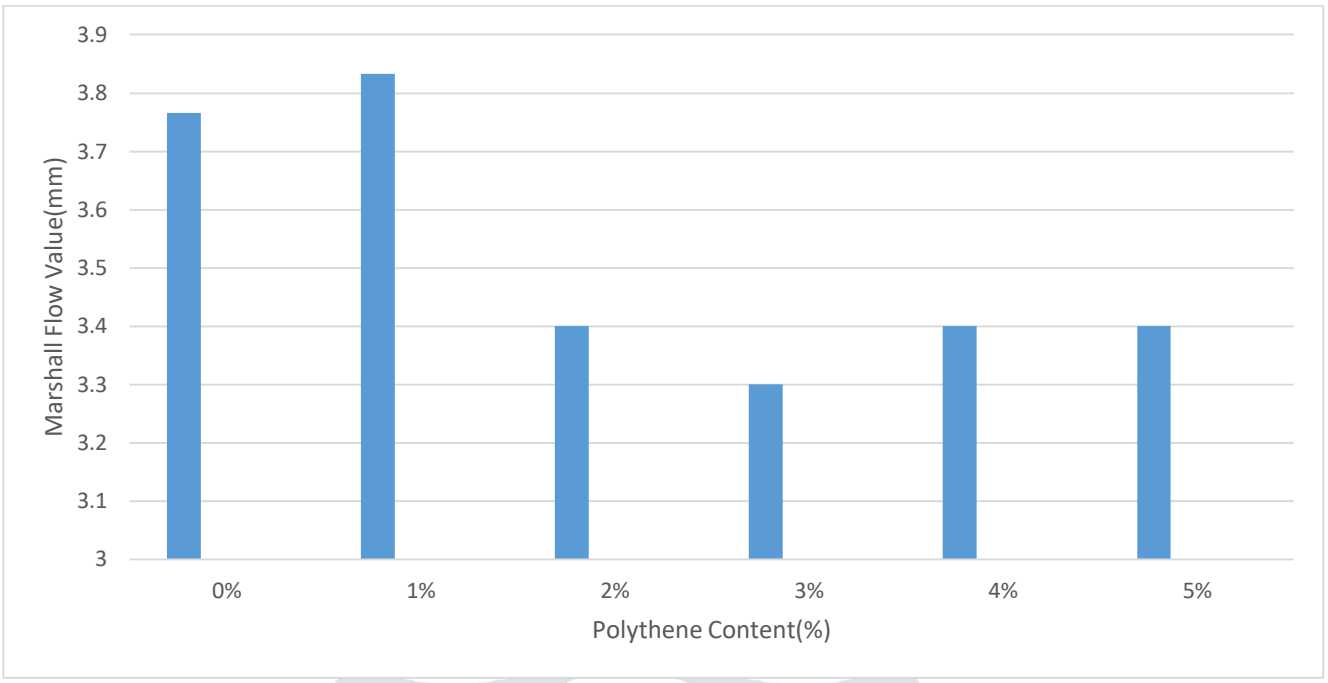

Fig 1.2: Marshall Flow Value vs. Polythene Content

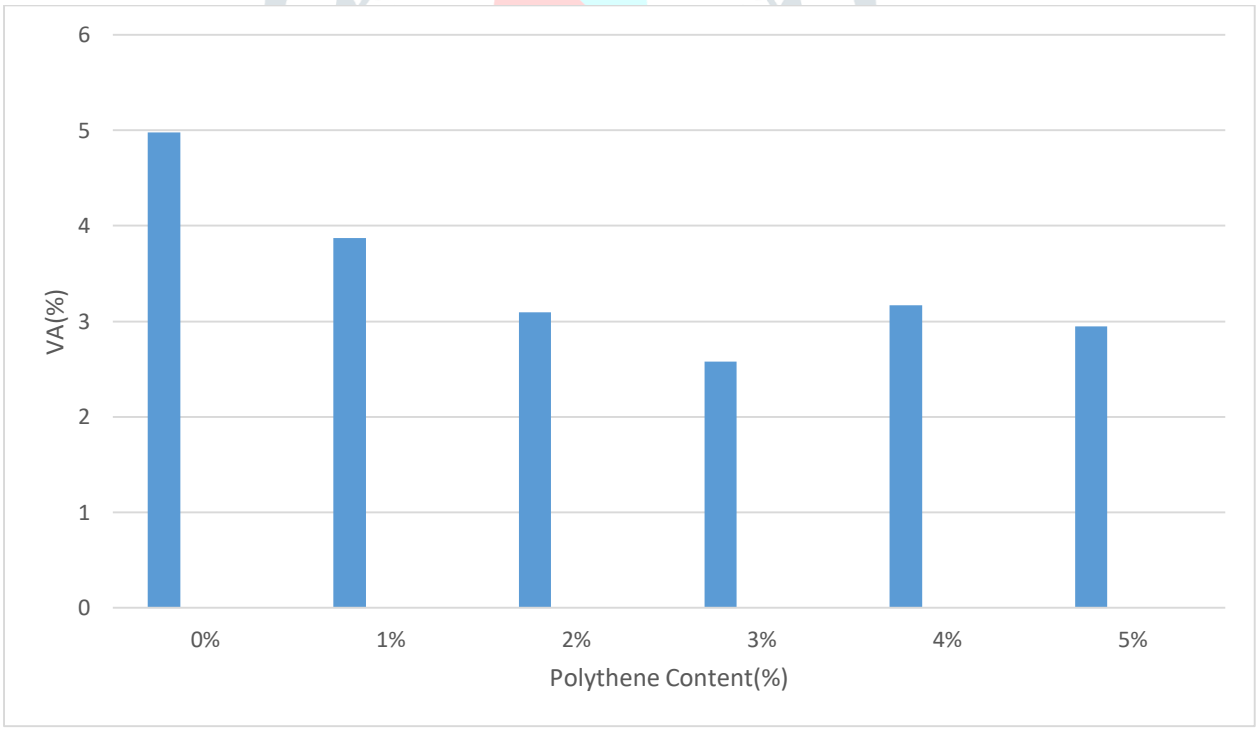

Fig 1.3 VA vs Polythene Content

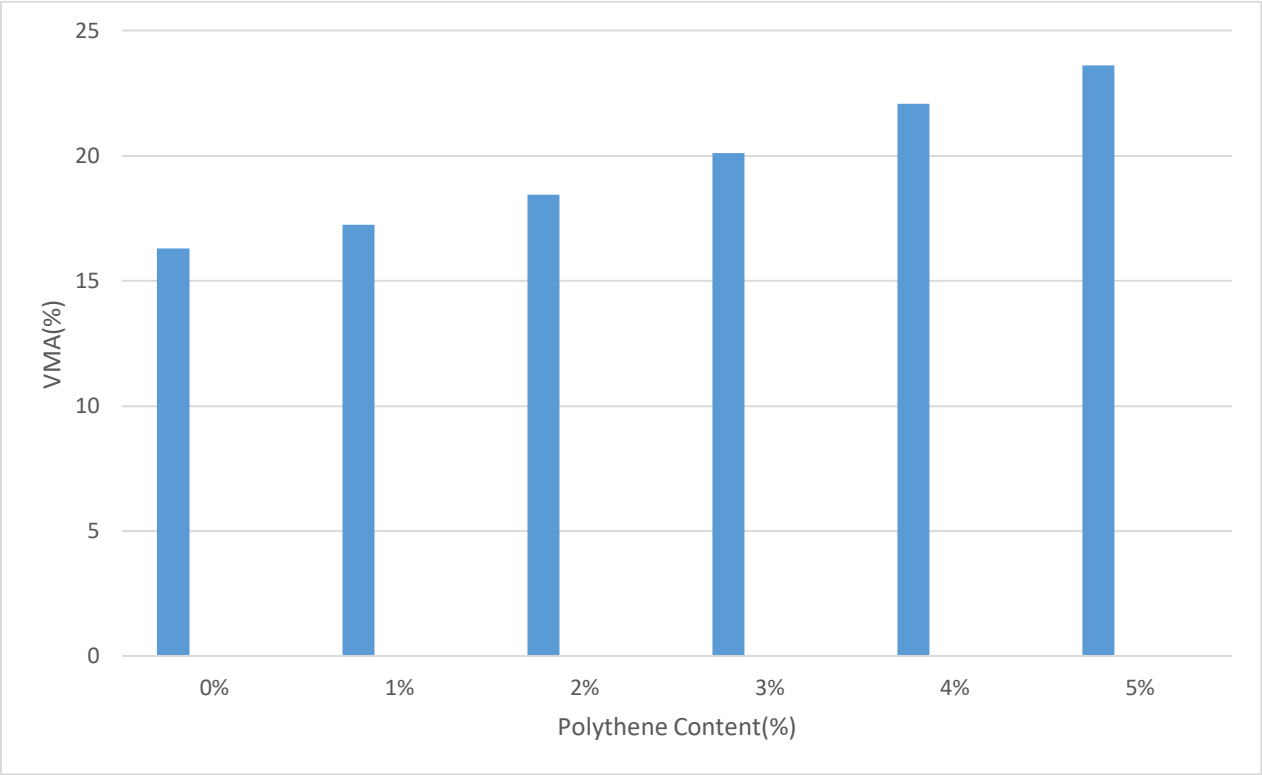

Fig 1.4: VMA vs. Polythene Content

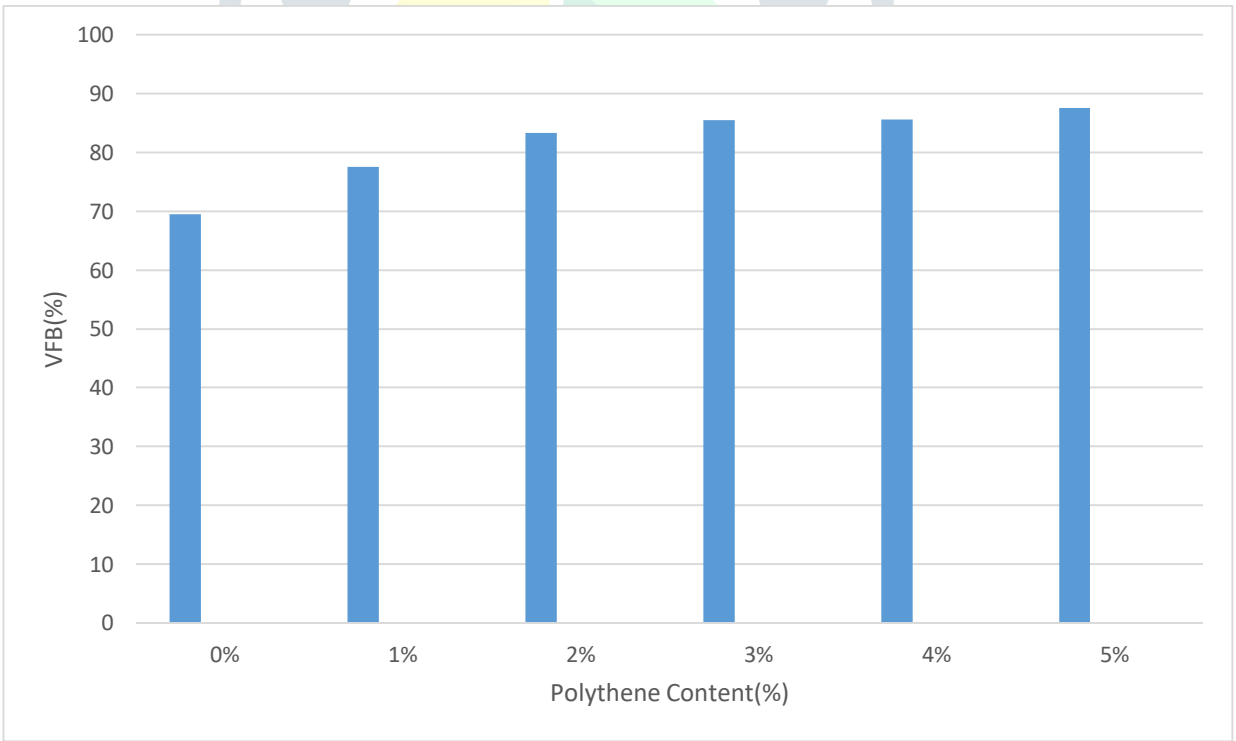

Fig 1.5: polythene content VS VFB

OPC: - is the content of polythene at which marshal stability value is maximum and its flow value is minimum is called optimum polythene content. From above Graph 5.1 and 5.2 optimum content of polythene is 4%

Conclusion:

On studying the properties of modified BC with polythene we got improvement in the marshal characteristics of mix compared with normal mix as under. Marshal stability values are enhanced up to polythene content of 4% thereafter any increase in polythene decreases the stability. On observing the results marshals' values decreases upon adding further polythene i.e. deformation resistance increases under heavy wheel loads. Parameters like VFB, VMA, VA are within required specifications.

In general, we can say that upon addition of modified polymer we obtain a more durable and stable mix for pavement. Thus the findings in this work show us that not only can we dispose waste plastics but can also improve the strength and stability of bitumen mixes with its addition.

Since India belongs to temperate weather zone. Its weather is hot and humid and often temperature reaches beyond 50 degrees centigrade sometimes, so the polymer modified pavement proves good substitute for this region. Heavy rains in monsoon leave roads in great distress and hence disturb life of pavement. But with addition of plastic wastes the life of roads is prolonged. Also this addition of plastics also reduces the environmental threat.

The bonding between bitumen and aggregates is increased due to increase in surface area of contact by coating these plastics wastes over the aggregates. Void spaces in mix are also reduced with the coating of this plastic wastes. Oxidation of bitumen by air entrapping is reduced with this modification with plastics. Thus the roads constructed with this show resistance to wear and tear and gives better service life. This research can also prove beneficial from environmental point of view as the waste plastic accumulation is reduced by using it in road construction. Soil conservation is also a benefit with usage of waste plastics in mix instead of disposing it in soil. This research recommends the further research in this field by producing more trial samples and the performance need to be studied.

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