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Research Article

A Laboratory Practice of using Plastic Waste in Bituminous Pavements to check feasibility

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Abstract

World-Class Fast Transportation is a need for every developing country. For that, the Highway pavements should in a good condition to achieve this goal as far as Land Transportation is considered. Bituminous Pavements are economical but the problem is it's high maintenance cost. To reduce this maintenance cost & to make it more economical, Bitumen is partially replaced by Plastic waste which solves the problem caused by disposal and burning of Plastic waste on the environment to large extent. In the Present Research, Possible numbers of experimental studies are done to understand the changes in the property of aggregate, bitumen as well as of bituminous mixes after utilization of waste plastic. The results show significant changes after the utilisation in different percentages.

Keywords: *Plastic Waste, Bitumen, Highway, Pavements, Polythene etc.*

1. Introduction

Flexible pavement comprises sub base, base and surface course over the prepared sub grade as shown in typical cross section. Material requirement and its specifications for each course are laid down in the form of IRC codes as well as several guidelines by competent authority such as MORTH, NHAI etc. Based on the guidelines it seems that binder is most important material required for the construction of bituminous surface course. Binder can be in form of bitumen, tar, or bitumen in form of emulsion, cutback etc. As bitumen is easily available and widely applicable under normal conditions, it is mainly used in the construction.

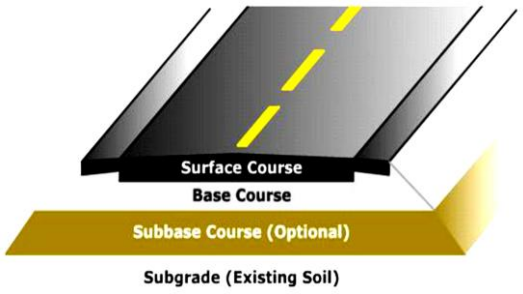

Fig.1: Cross Section of Flexible Pavement

Bitumen is a useful binder for road construction. Different grades of bitumen like 30/40, 60/70 and 80/100 are available on the basis of their penetration values. The steady increase in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature demand improved road characteristics. In present scenario, after every monsoon, bitumen loosens the aggregates and results into the separation of aggregates from interlocked aggregate layer. Recently, our local government body, Ahmadabad Municipal Corporation (AMC) also announced to improve the quality of bitumen binding course by addition of plastic material into bituminous mixes.

Fig.2: Non-Biodegradable Plastic Waste

Objectives

- To Study the current situation and major problems in some countries in the generation, reduction, reuse, recycling, handling, collection, transfer and

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transport, transformation and disposal of Plastic waste.

- To gain information on the prevailing technologies and practices of Plastic waste management collection, transformation, and disposal.
- To use the plastic waste in the road construction.
- To improve durability, stability and strength of road.

Aim

- To Improve Durability of road.
- To Improve Strength of road.
- To make better Environment which is polluted by the plastic waste by re-using it.

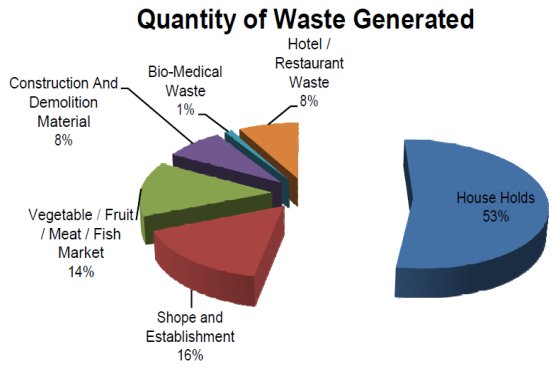


Fig.3: Waste Generation from different sources

2. Literature Survey

Amit Gawandea, G. Zamarea *et al*. developed techniques to use plastic waste for construction purpose of roads and flexible pavements has reviewed. In conventional road making process, bitumen is used as binder. Such bitumen can be modified with waste plastic pieces and bitumen mix is made which can be used as a top layer coat of flexible pavement. This waste plastic modified bitumen mixshow better binding property, stability, density and more resistant to water.

Miss Apurva J Chavan done a thorough study on the methodology of using plastic waste in bituminous mixes and presented the various tests performed on aggregates and bitumen. 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. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes.

Krishnaswamy N.R.,Shesha Prakash *et al*. focused on the productive utilization of discarded and used High Density Poly-Ethylene (HDPE) bag fabrics as a geotextile material in the construction of rural roads. The properties of HDPE bag fabrics for their efficient use have been explored. Suitability can be tested by finding the tensile strength properties of the HDPE bag fabrics using CBR Plunger Push through Test (ASTM D4833). The desired equipment for testing the same can be found in any undergraduate level technical institutions.

Praveen Kumar, Ankit Gupta evaluated the possible causes of pavement distresses and to recommend remedies to minimize distress of the pavement. The paper described lessons learnt from pavement failures and problems experienced during the last few years on a number of projects in India. Based on the past experiences various pavement preservation techniques and measures are also discussed which will be helpful in increasing the serviceable life of pavement.

Muhammad Shahjahan comprised of a ground investigations (using trial pits and hand auger) of all three road types that included a significant embankment. Inside properties were determined using standard penetration tests, density determination and Benkelman beam tests and laboratory investigations included determination of moisture content, index properties of soil, dry density/moisture content relationship and strength tests. Some cyclic load tests were also conducted. The study also included assessment of previously available information from ground investigations. Results of the investigations showed that there was limited amount of previous information and that which was available did not often contain the required information.

3. Experimental Work

Marshall Stability test

The specimen was prepared as per the IRC specification using plastic waste-blended bitumen. This shows that plastic waste-bitumen blend has higher strength compared to pure bitumen, whose value is approx. 1200Kg.

Moreover, the Marshall Quotient is also within the range of tolerance, thus showing that the plastic waste (polyethylene) blended bitumen mix is better and more suitable for flexible pavement construction.

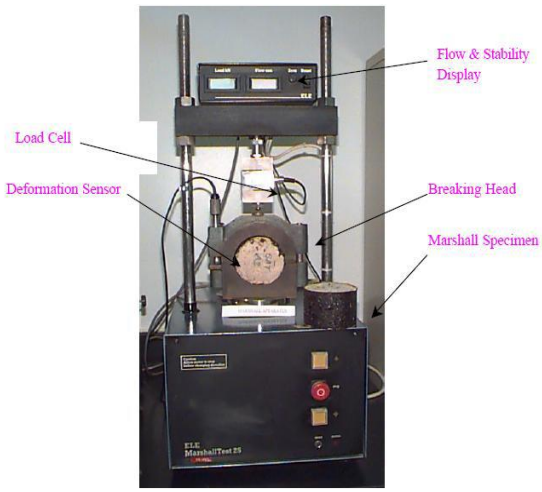


Fig.4: Marshall Stability & Flow Test Setup

Preparation of Marshall Mould

The mixing of materials required for mould preparation was done as per the following procedure:

- Required quantities of coarse aggregate, fine aggregate & mineral fillers were taken in an iron pan.
- This was kept in an oven at temperature 160 c for 2 hours. This is because the aggregate and prepared blends are to be mixed in heated state so preheating is required.
- The prepared blend also heated up to its melting point prior to the mixing.
- The aggregates in the pan kept in oven were taken and heated on control gas stove for a few minutes maintaining the temperature.
- Now blend (72 gm.), i.e. 6% was added to this mix and the whole mix was mixed uniformly and homogenously. This was continued for 15-20 minutes till they were properly mixed.
- Then the mix was transferred to the Marshall sampling mould.
- The mix in the mould was then compacted by the Marshall hummer. 75 numbers of blows were given on each side of the sample so a subtotal of 150 no. of blows was given for sample.
- Then the samples with mould were kept separately and marked accordingly to the percentage of polythene added by weight of bitumen.

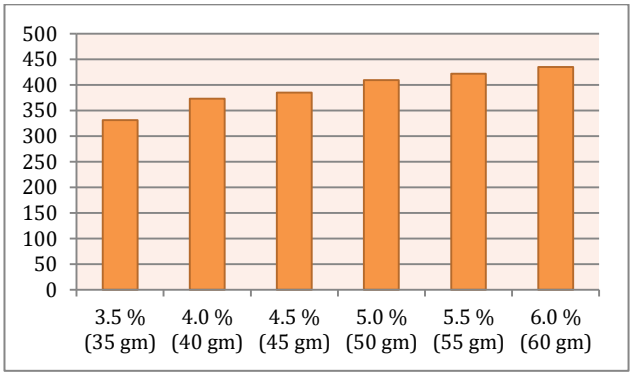
Fig.5: Heating & Plastic Coating Aggregates

Fig.6: Compaction of Mix by Marshall Hammer

4. Results

Table 1: Marshall Stability Value For Bitumen

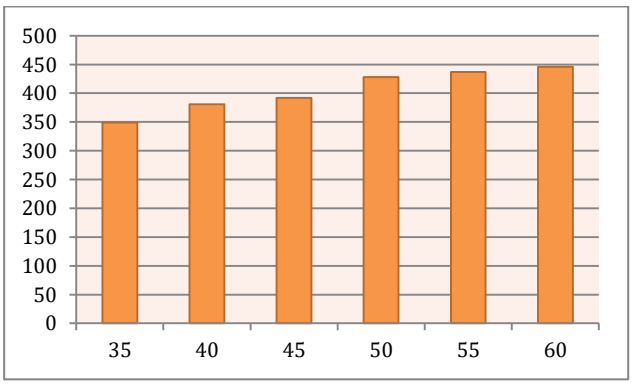
Content (Agg. +Bitu. +Pla.)	Plastic	Bitumen	Stability (Kg)
1000gm	NIL	3.5 % (35 gm)	331
1000gm	NIL	4.0 % (40 gm)	373
1000gm	NIL	4.5 % (45 gm)	385
1000gm	NIL	5.0 % (50 gm)	409
1000gm	NIL	5.5 % (55 gm)	422
1000gm	NIL	6.0 % (60 gm)	435



Graph-1: Bitumen % v/s Stability Value

Table 2: Marshall Stability Value for Bitumen-Plastic Waste

Content (Agg. +Bitu. +Pla.)	Plastic	Bitumen	Plastic + Bitumen	Stability (Kg)
1000gm	3.5 % (1.225 gm)	33.78	35	349
1000gm	4.0 % (1.60 gm)	38.4	40	381
1000gm	4.5 % (2.025 gm)	42.98	45	392
1000gm	5.0 % (2.5 gm)	47.5	50	428
1000gm	5.5 % (3.025 gm)	51.98	55	437
1000gm	6.0 % (3.60 gm)	56.4	60	446



Graph-2: Bitumen+Plastic % v/s Stability Value

Conclusion

The Present study concludes that the bitumen modified with 6% polythene waste is showing better

performance as compared to other mixes. The Marshall stability which is a strength parameter has shown increasing trend with a maximum increase in stability value compared to conventional mix when modified with 6% polythene waste. It is observed that Marshall Stability value increases with polythene content up to 6% and thereafter decreases. Thus the use of higher percentage of waste polythene is not preferable. The research reflects the use of waste material smartly considering Pollution factor in mind.

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