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Performance Evaluation of Recycled Asphalt By Addition of Suplamentory

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Abstract— The quantum of plastic waste in Municipal Solid Waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in life style, which leads widespread waste on the landscape. Therefore, the disposal of waste plastic is a menace and become a serious problem globally due to their non-biodegradability and unaesthetic view. The present study focuses on using the plastic waste as well as reused bitumen rather than to dispose them. The main objectives of the present research is to characterize the bitumen which has been extracted from four selected roads (NH, SH, MDR, ODR, VR) before and after the addition of plastic waste through the determination of engineering properties. Laboratory tests 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 may fall within the specified range of 5-8% range specified. The results of our study reveal that addition of plastic waste to the recycled bitumen mix will enhance the stability, density and more resistant to water. This way one can reduce the ground water pollution and soil degradation.

Index Terms-—*Recycling; Bitumen Mix; Ductility; Softening; Penetration; Used Asphalt Pavement*

I. INTRODUCTION

The threat of disposal of plastic will not solve until the practical steps are not initiated at the ground level. It is possible to improve the performance of bituminous mix used in the surfacing course of roads. Studies reported in the used of re-cycled plastic, mainly polyethylene, in the manufacture of blended indicated reduced permanent deformation in the form of rutting and reduced low – temperature cracking of the pavement surfacing. The field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. Population growth and economic development have resulted in an extensive network of asphalt paved roads. Several kilometers were constructed to meet the demands of the people.

Plastic is a versatile material. Due to industrial revolution, and its large scale production plastic seemed to be a cheaper and effective raw material. Today, every vital sector of the economy starting from agriculture to packaging, automobile, electronics, electrical, building construction, communication sectors has been virtually revolutionized by the applications of plastics. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste. The health hazard includes reproductive problems in human and animal, genital abnormalities etc., Looking forward the scenario of present life style a complete ban on the use of plastic cannot be put, although the waste plastic taking the face of devil for the present and future generation. We cannot ban use of plastic but we can reuse the plastic waste.

Bitumen is a useful binder for road construction. 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. Any improvement in the property of the binder is the need of the hour. The addition of polymers typically increases the stiffness of the bitumen and improves its temperature susceptibility. Increased stiffness improves the rutting resistance of the mixture in hot climates and allows the use of relatively softer base bitumen, which in turn, provides better low temperature performance. Use of waste plastic in bitumen has revealed improved performance, stability, strength and fatigue life, reduction in overall rutting, and low-temperature cracking of the bituminous surfacing. Apart from solving the problem of waste disposal, addition of waste plastics in bituminous mix results in reduction in consumption of bitumen thereby resulting in overall cost reduction). Salient features of the polymer-waste-bitumen mix road (Verma 2008; Gawande et al. 2012; Chavan AJ, 2013):

- road strength is twice stronger than normal roads.
- resistance towards water stagnation, plastic in bitumen provides im-permeability to the mix.
- less bleeding during summer.
- burning of plastics waste could be avoided.
- It doesn't increase cost of road construction.
- It helps to reduce the consumption of bituminous mix.
- It helps in protecting our environment from waste plastic.

In this study we report the reuse of waste of PVC pipes in the modification of bitumen for paving applications. The visco-elastic properties of the modified bitumen and the mechanical properties of the bituminous mix produced by this modified bitumen are investigated and compared to the neat bitumen.

The main aim of the present study is to utilize the bitumen extracted from used asphalt pavement by the addition of plastic waste for road construction. The objectives of the study is to characterize extracted bitumen from UAP by the addition of plastic waste through the determination of Engineering properties and to establish the effects of age on asphalt content, penetration and viscosity of recovered bitumen.

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II. PLASTIC WASTE CLASSIFICATION

Plastics can be classified in many ways, but most commonly by their physical properties. Plastics may be classified also according to their chemical sources. The twenty or more known basic types fall into four general groups: Cellulose Plastics, Synthetic Resin Plastics, Protein Plastics, Natural Resins, Elastomers and Fibers. But depending on their physical properties, may be classified as thermoplastic and thermosetting materials. Thermoplastic materials can be formed into desired shapes under heat and pressure and become solids on cooling. If they are subjected to the same conditions of heat and pressure, they can be remolded. Thermosetting materials which once shaped cannot be softened / remolded by the application of heat. The examples of some typical thermoplastic and thermosetting materials are tabulated in Table 1.

Table 1 Typical Thermoplastic and Thermosetting Resin

S. No.	Thermoplastic	Thermosetting
1	Polyethylene Teryphthalate (PET)	Bakelite
2	Polypropylene (PP)	Epoxy
3	Polyvinyl Acetate (PVA)	Melamine
4	Polyvinyl Chloride (PVC)	Polyester
5	Polystyrene (PS)	Polyurethane
6	Low Density Polyethylene (LDPE)	Urea – Formaldehyde
7	High Density Polyethylene (HDPE)	Alkyd

Most of thermoplastics on heating soften at temperature between 130-140oC. The TGA analysis of thermoplastics has proven that there is no gas evolution in the temperature range of 130-180oC and beyond 180oC gas evolution and thermal degradation may occur. Thus the waste plastic can easily be blended with the bitumen as the process for road construction using bitumen is carried out in the range of 155-165^{o}C. Table 2 gives the source of waste plastic generation.

Table 2 Waste Plastic and its Source

Waste Plastic	Origin
Low Density Polyethylene (LDPE)	Carry bags, sacks, milk pouches, bin lining, cosmetic and detergent bottles.
High Density Polyethylene (HDPE)	Carry bags, bottle caps, house hold articles etc.
Polyethylene Teryphthalate (PET)	Drinking water bottles etc.
Polypropylene (PP)	Bottle caps and closures, wrappers of detergent, biscuit, vapors, packets, microwave trays for readymade meal etc.,
Polystyrene (PS)	Yoghurt pots, clear egg packs, bottle caps.
Polyvinyl Chloride (PVC)	Mineral water bottles, credit cards, toys, pipes and gutters; electrical fittings, furniture, folders, and pens, medical disposables; etc

III. MATERIALS AND METHODS

Materials are composed of samples of different selected roads. The research would be conducted on those samples by adding different percentages of plastic waste to the extracted bitumen. Bitumen samples are collected at ongoing rehabilitation sites. Plastic wastes have been collected and are made fine so that they can be added to bitumen. Materials and equipments used in the present study are given as follows:

- Benzene
- Plastic waste
- Extracted bitumen
- Bitumen extractor
- Penetrometer
- Ductility testing machine
- Ring and ball apparatus
- Induction

- Pensky martin's flash and fire apparatus

Waste plastic bags were collected from roads, garbage trucks, dumpsites and compost plants, rag pickers, waste-buyers at Rs5-6 per kg. Household plastic was also collected for the project work, like empty milk bags, used plastic bags etc. The collected plastic waste was sorted as per the required thickness. Generally, polyethylene of 60 micron or below is used for the further process. Less micron plastic is easily mixable in the bitumen at higher temperature (160°c-170°c).It is clean by de dusting or washing if required. Collected Plastic was cut into fine pieces as far as possible. The plastic pieces were sieved through 4.75mm sieve and retaining at 2.36mm sieve was collected. Firstly, Extracted Bitumen was heated up to the softening temperature. Pieces were added slowly to the hot bitumen of temperature around 160-170°c. The mixtur e was stirred manually for about 20-30 minutes. In that time period temperature was kept constant about 160-170°c. Polymer-bitumen mixtures of different compositions were prepared and used for carrying out tests i.e., Penetration test, Ductility test, Flash point test
& Fire point test, Ring and ball test and The results of the present study are given in Table 3 and Figure 1.

Table 3: Results of Recycled Bitumen before and addition of plastic waste

% addition of plastic waste → / Name of the test ↓	0	1	2	3	4	5	6	7	8	9
Penetration value	68	7.3	6	5.3	4.6	4	3.3	3	2.6	1.6
Ductility value	5.2	4.9	4.8	4.3	4	3.4	3	2.8	2.3	1.2
Softening point	82	84	86	88	90	93	95	97	99	100
Flash Point	245	250	256	260	265	270	276	280	290	300
Fire point	255	266	269	273	279	285	287	294	310	316

IV. RESULTS AND DISCUSSION

The results are analyzed as follows:

- The average extracted bitumen from UAP on Road samples ranged from 5.0 to 6.0 % which fell within the specified limits of 5.00 – 8.00 %.
- Furthermore, the penetration and viscosity ranged from 32.3 to 67.4 and 9,660.9 to 16,465.3 respectively.
- Used Asphalt Pavement (UAP) binder may have penetration values from 10 to 80 and absolute viscosity values at 60°C (140°F) in a range from as low as 2,000 poises to as high 50,000 poises or greater.
- The increase in percentage of polymer decreased the penetration value. This shows that the addition of polymer increases the hardness of the bitumen. The penetration values of the blends are decreasing depending upon the percentage of polymers and the type of polymer added.
- The ductility decreased by the addition of plastic waste to bitumen. The decrease in the ductility value may be due to interlocking of polymer molecules with bitumen.
- Flash and fire point increased with the increase in the percentage of polymer. The polymer bitumen blend road surfaces are less affected by fire hazards.

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