Utilization of Waste Plastic in Road Construction

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Abstract— Now days, the steady increment in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature put us in a demanding situation to think of some alternatives for the improvisation of the pavement characteristics and quality by applying some necessary modifications which shall satisfy both the strength as well as economical aspects. Also considering the environmental approach, due to excessive use of polythenes in day to day business, the pollution to the environment is enormous. Since the polythenes are not biodegradable, the need of the current hour is to use the waste polythene in some beneficial purposes. In present study various percentages of polythene are used for preparation of mixes with a selected aggregate grading. Marshall Properties such as stability, flow value, unit weight, air voids are used to determine optimum polythene content for the given grade of bitumen.

Index Terms— Waste Plastic, pavement, Marshall Stability

I. INTRODUCTION

India is developing country with amazing rate of economic development, in recent decade the rate of economic growth has been dramatic and is set in one of fastest developing economics in the world. The growth in various types of industries together with population growth has resulted in enormous increase in production of various types of waste materials.. The creation and disposal of non-decaying waste materials such as Blast Furnace Slag, Fly-ash, Steel Slag, Scrap Tyres, Plastics, etc. have been posing difficult problems in developed as well as in developing countries. Considerable work has been done in various countries for the disposal of some of these waste products and utilization of some other products and there is a long list of published literature dealing with different aspects of these challenging problems. Attempts are still being made by various organizations and researchers to find methods for effective utilization of some of these waste materials. Of these, the efforts to find useful applications of some of the waste products in highway construction have given encouraging results. The use of thin plastic bags to pack and to carry various materials including house hold articles have become a common practice all over the country. However the disposal of the waste plastic bags in large quantities has been a problem and is of great concern, particularly in big cities. The mixing up of these waste plastic bags with other bio-degradable organic waste materials in the garbage of the urban areas has been the main cause of the problem. Therefore attempts are being made in some cities to limit or even to prohibit the use of the thin plastic bags for packing and other common use, so as to control this "undesirable waste material" from getting mixed up with the other organic garbage.

Use of waste plastic in road construction is one of emerging advanced technology getting famous now days which not only solve problem of waste plastics but also save the environment. Generally, the polymers are either blended or dispersed with bitumen and the mix is used as the modified binder. This process has its own limitations like poor solubility of polymers in bitumen and the separation of the polymers from the dispersed bitumen, if present in higher percentage

II. NECESSITY OF WORK

a) Plastic mainly consists of low-density polyethylene and more durability than regular bitumen roads.
b) Eco-friendly recycling of plastic wastes so plastic waste management will be done up to certain extent. And Eco-friendly process.
c) This will provide more stable and durable mix for the flexible pavements. The serviceability and resistance to moisture will also be better when compared to the conventional method of construction.
d) The polymer modified bitumen show better properties for road construction and plastics waste which otherwise are considered to be a pollution menace.
e) Improvement in properties of bituminous mix provides the solution for disposal in a useful way.
f) Poor locally available aggregates can make into use by coating them with waste plastic which will ultimately reduce the haulage cost & improves the physical properties of aggregates.
g) Stone aggregate is coated with the molten plastic waste. The coating of plastics reduces the porosity, absorption of moisture & improves stripping value.

III. PLASTIC WASTE MANAGEMENT

Disposal of plastic waste is a serious concern in India. New technologies have been developed to minimize their adverse effect on the environment. Currently worldwide accepted technology used for the plastic disposal is incineration. However, the incinerators designed poorly, releases extremely toxic compounds (chlorinated dioxins and furans) therefore, facing strong opposition from various non-government organizations. In India to introduce a safer disposal technology various new technologies were experienced shown in fig

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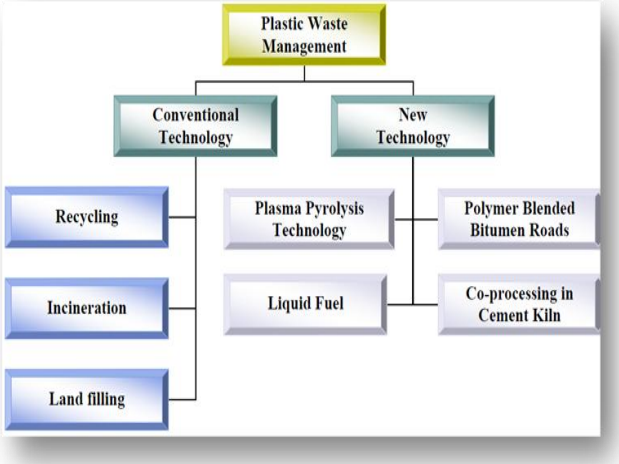

Fig No 1- Plastic Waste Management

IV. LABORATORY EXPERIMENT AND RESULT ANALYSIS

Numbers of tests were carried on the materials that are to be used in preparation of bituminous concrete specimen for their suitability according to MORTH 2001 as well as respective IS Codes for the following materials:

a) Aggregates
b) Bituminous Binder.
c) Polythene

Selection of proper gradation for the mix is one of the most important parameter. Ministry of road transport [MORTH] has given some of the grading specifications for all the bituminous and non-bituminous layers used in road construction. It is recommended that the bitumen should be accepted on certification by the supplier (along with the testing results).

Shredding:

The dried polythene packets were cut into tiny pieces of size 2 mm maximum. This is because when the polythene is to be added with bitumen and aggregate it is to be ensured that the mixing will be proper. The smaller the size of the polythene, the more is the chance of good mixing

Marshall Stability Test:-

This test is done to determine the Marshall stability of bituminous mixture as per ASTM D 1559. Marshall Stability is the resistance to plastic flow of cylindrical specimens of a bituminous mixture loaded on the lateral surface.

Marshall Stability Value:-

It is defined as the maximum load at which the specimen fails under the application of the vertical load. Generally, the load was increased until it reached the maximum & then when the load just began to reduce, the loading was stopped and the maximum load was recorded by the proving ring.

Marshall Flow Value –

It is defined as the deformation undergone by the specimen at the maximum load where the failure occurs. During the loading, an attached dial gauge measures the specimen's plastic flow as a result of the loading.

Fig No-2 Photographs of Experimental Work

V. OBSERVATIONS OF TESTING

The tests were conducted on various samples and their results tabulated in table No1:

Following observation were recorded during test for each sample

- Mass of aggregate In mixing pan
- Mass of bitumen added
- Mass of plastic added
- Bitumen content
- Plastic content
- Mixing temp.- aggregate
- Mixing temp -bitumen
- Compacting temp.
- No. of blows with hammer per face
- Mass of specimen in air ‘wa’
- Mass submerged ‘ww’
- Mass of saturated surface dry ‘ws’
- Volume of specimen ‘v’
- Flow value

- Marshall stability value
- Specific gravity of mix = (W2-W1)/(W3-W1)-(W4-W2)
- Volume of bitumen Vb = (bitumen content * density)/ sp. Gravity of aggregate
- Volume of aggregate Va = (100- bitumen content) * density / sp. Gravity of agg
- Voids in miniral aggregate
- V.M.A = (100-VA)
- Voids in mix, Vm = 100 –(Vb+ Va)
- Voids filled with bitumen =V.F.B. =100* Vb / V.M.A.

***Results For 5% plastic waste in mix*:**

In this case in each sample bitumen is replaced by plastic waste. Eight numbers of samples were tested for various bitumen content i.e. 3%, 3.5%, 4%, 4.5 %, 5.0 %, 5.5 %, 6.0 % & 6.5%. The results are given in Table

Table No 1:- Results for 5 % plastic waste

Sr. No.	% of Bitumen	Weight of sample (gm)	Height (cm)	Bulk density (gm/cc)	% Air Voids	% V.M.A.	Stability (KN)	Flow
1	3	1338	7.4	1954	5.74	31.02	17.98	2.54
2	3.5	1294	7.3	2020	5.53	31.29	18.34	2.92
3	4	1297	7.3	2041	5.39	31.5	19.03	3.45
4	4.5	1308	7.3	2056	5.13	32.1	19.54	3.78
5	5	1295.5	7.3	2030	4.91	32.51	19.91	4.1
6	5.5	1374	7.5	1992	4.96	33.21	19.74	4.51
7	6	1332	7.4	1950	5.02	33.65	19.45	4.73
8	6.5	1326	7.4	1881	5.07	33.85	18.87	4.96

Like this we take reading for various % of waste plastic and noted down readings and various graphs related to stability were plotted. Following are some of sample graphs

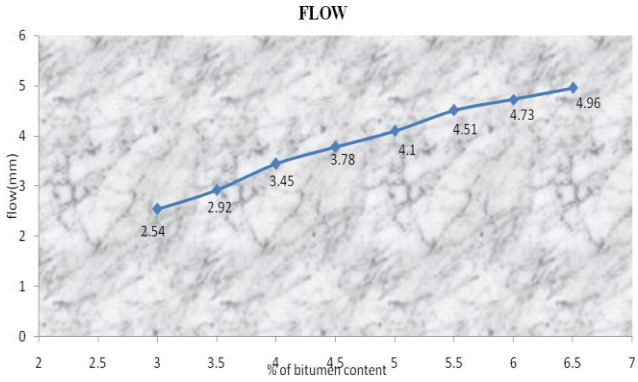

Fig No- 3 Flow (mm) Vs % of bitumen content for 5% plastic mix

Fig No-4 Stability (KN) V/s % of bitumen content for 5% plastic mix

Summary of Stability (KN):

% Bitumen Content	Stability(KN)		
	5 % Bitumen replaced by plastic waste	10 % bitumen replaced by plastic waste	15 % bitumen replaced by plastic waste
4.5 %	19.54	20.81	18.32
5.0 %	19.91	21.03	18.52
5.5 %	19.74	20.87	18.32
6.0 %	19.45	20.45	17.86

VI. CONCLUSIONS

From the study of the behavior of polythene modified Bituminous concrete it was found that the modified mix possesses improved Marshall Characteristics as mentioned below. It is observed that Marshall Stability value increases with polyethylene content up to 10% and thereafter decreases. We observe that the Marshall Flow value decreases upon addition of polythene i.e. the resistance to deformations under heavy wheel loads increases. Considering these factors we conclude that we can obtain a more stable and durable mix for the pavements by polymer modifications. This small investigation not only utilizes beneficially, the waste non-degradable plastics but also provides us an improved pavement with better strength and longer life period

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