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Modify Design of Flexible Pavement to Enhance Its Strength for Indian Road Conditions

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Abstract: Now a days, disposal of plastic waste has become issue of great concern for environmental engineers due its non biodegradable characteristics and health hazard. The reasons due to which bitumen is mostly used as a binding material are its excellent binding characteristics, waterproofing properties and low cost as compared to other binders.

Due to the critical shortage of natural aggregate, the availability of demolished concrete for use as recycled concrete aggregate (RCA) is increasing. The application of recycled aggregate has been started in many countries for construction projects. Recycled coarse aggregate (RCA) obtained from crushed concrete rubble, instead of being stored, can be reused in building industry. The main aim of this project is to add various types of disposal plastic to modify design for enhance road strength.

Keywords: Flexible Pavement, Marshal Stability, Plastic Waste, Bitumen, Aggregate, Plastic-bitumen-aggregate mix.

I. INTRODUCTION

Disposal of plastic waste from various sources has been a matter of concern from a long period. These plastic waste can cause different types of pollution to the environment. Until now many of the plastic were just landfilled or buried and only a small part was recycled. This problem for human health has made the government to support some companies for building up the recycling industry of the waste plastic. One of the possible solutions for the use of waste plastic is through recycling process and to incorporate it into aggregate & bitumen for improvement of the quality of road constructions.

II. AIM & OBJECTIVES

A. Aim

To modify design of flexible pavement to enhance its strength for Indian road conditions.

B. Objectives are as followed

- 1) To coat the aggregates with the waste plastic materials & add some amount of plastic in bitumen
- 2) To check the properties of bituminous mix specimen with coating of waste plastic materials.
- 3) To utilize the waste plastic as useful binding material.

III. METHODOLOGY

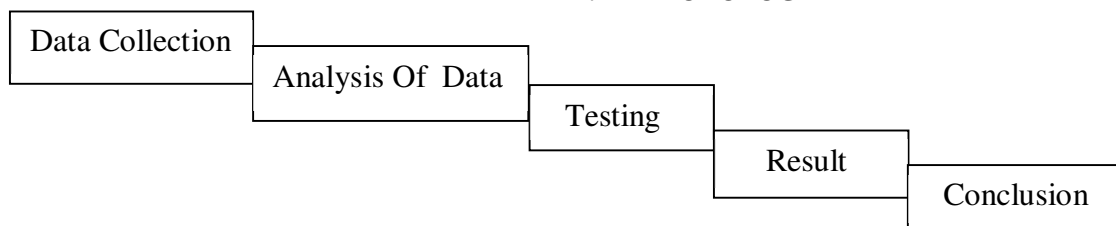


Fig.1 Methodology chart.

A. Material

- 1) **Bitumen:** The bitumen used for the present work is 60/70 penetration grade and has been widely used for paving application; it is used as binder in present work. The bitumen is melted in 160-165°C. All tests conducted on bitumen were in accordance with procedure laid down in I.S. The basic test properties conducted on bitumen and modified bitumen indicates that the replacement of bitumen by waste plastic decrease the penetration and ductility value, whereas increase in softening point and specific gravity value, when about 4.5% weight of bitumen.

- 2) *Aggregate*: Aggregate forming the main skeleton of pavement should be tested against their suitability as a pavement construction material.
- 3) *Plastic*: The plastic waste has been taken as polyethylene waste in different percentage such as 0%, 5%, 10%, 15% and 20% . Thus, the waste plastic can easily be mix with the bitumen as the process for road construction using bitumen is heat in the range of 155-165°C.

B. Test

- 1) *Penetration test on Bitumen*: The penetration test of bitumen measures the hardness or softness of bitumen by measuring the depth of penetration of a standard loaded needle in five seconds while maintaining the bitumen sample temperature at 25 °C
- 2) *Ductility test on Bitumen*: The ductility gives a measure of adhesive property of bitumen and its ability to stretch. In a flexible pavement design it is necessary that the binder should form a thin ductile film around the aggregate, so that physical interlocking of the aggregate is imposed. Binder material having insufficient ductility gets cracked when subjected to repeated traffic loads and provides pervious pavement surface. Ductility of bituminous material is measured by the distance in centimeters to which it will elongate before breaking when two ends of a standard mould of material are pulled apart at a specific temperature.
- 3) *Marshall Stability Test*: The aggregate taken in use has been passed through 12.5 mm sieve and were retained on 10 mm sieve. The aggregate has been heated in a pan for 20 min so that moisture and dust get removed. Bitumen test were performed and grade of bitumen was observed as 60/70. The bitumen was heated in a pan until It melts and then the calculated amount of plastic was added. It is stirred for 1 min. To the melted mixture of bitumen and plastic heated aggregate added until it get uniform color throughout. it is taken out and putted in a mold of diameter and height in three layer , 75 blows were given after each layer. The sample is taken out from the mold after 4 hours. and left for a duration of 24 hours . the sample is putted in hot water bath of temperature of and marshal stability test was on these sample ,the reading of each sample has been noted and compared with the standard reading of bitumen concrete.

Sample No	Sample name	Bitumen and plastic%	Bitumen content (gm)	Plastic Content (gm)
1	Normal	4.5	45	0
2	P1	4.5	42.75	2.25
3	P2	4.5	42.75	4.5
4	P3	4.5	38.25	6.75
5	P4	4.5	36	9

TABLE NO.1 - Tabulation of sample taken.

Normal - sample mould without plastic

P1 - sample mould with plastic 5%

P2 - sample mould with plastic 10%

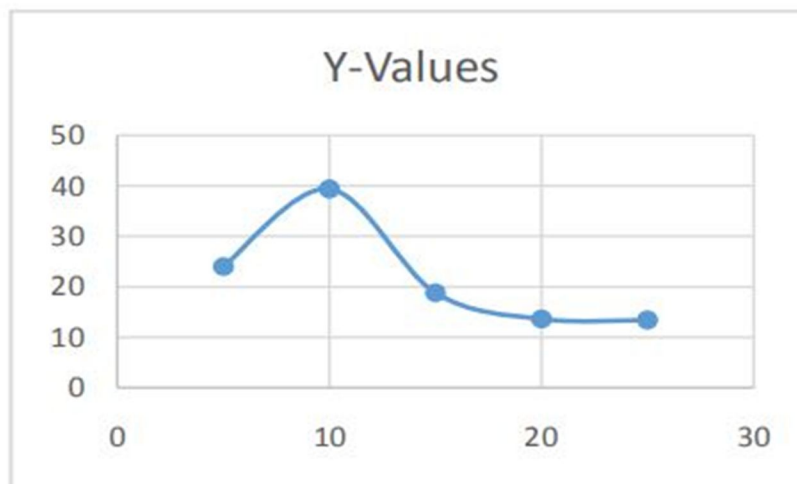
P3 - sample mould with plastic 15%

P4 - sample mould with plastic 20%

Observation for the Marshall stability.

Bitumen	% of plastic	Stability(mm)
Without Plastic	0	15.8
With Plastic	5	24
With Plastic	10	39.4
With Plastic	15	18.8
With Plastic	20	13.6

TABLE NO.2 - Result of Marshall Stability test



X - Axis is percentage of plastic added

Y - Axis is stability of mould prepared

The graph results shows the higher percentage of plastic (more than 15%) results in lesser compatibility with bitumen and lesser bonding resulting in lesser marshal stability value.

IV. LITERATURE REVIEW

Nikhil H Pitale et al. (2014) [5] in this study it was found that the properties of Bituminous Concrete mix were enhanced by the use of plastic. Utilize of plastic waste 0.76 % by weight of aggregate and 3 % filler significantly enhanced the volumetric properties of bituminous mixes and shows good performance with plastic waste than the nominal control mix .Use of this innovatory technology not only increases the road life but strengthened the road construction and also helps to reform the environment. Plastic road was a benefited for India's hot and extremely humid weather which was relived the earth from all type of plastic waste. This small investigation was not only beneficial but enhances the pavement with good strength with increased design life of the pavement.

Shivani Singh Dhriyan1 (2017) The use of plastic waste to modify the bitumen properties, which will be used for the construction of road, has resulted in the reduction of the cost of construction and eco-friendly disposal method of the plastic waste. As use of waste plastic is increasing due to industrialization and increase in population results into various environmental problem. Hence, using waste plastic in the construction of flexible pavement is economical and ecofriendly method. Rokde (2012), proposed to use plastic and rubber user friendly but not eco-friendly and non- biodegradable. In this study an attempt has been made of using plastic waste (LDPE) and crumb rubber. Blend using dry process for LDPE and wet process for CRMB. He takes 60/70 grade bitumen mixing with LDPE and CRMB using dry process and wet process in different proposition and adopted.

V. SCOPE OF PROJECT

The present study will focus basically on these following points:

- 1) To reduce the bitumen content by the addition of Waste plastic in bituminous mix.
- 2) The lifespan of the roads can be increased.
- 3) Eco-friendly in nature.

The laboratory investigations on the bituminous mix have been carried out as per the Indian Standards used for the road construction. The field application is out of the scope of work.

VI. RESULT & CONCLUSION

- 1) Graph results shows the higher percentage of plastic (more than 15%) results in lesser compatibility with bitumen and lesser bonding resulting in lesser marshal stability value.
- 2) Cost of modified bitumen is reduced when compared with conventional bitumen.
- 3) Modified bitumen possess increased stability and durability compared to neat bitumen..
- 4) The result shows that with increase of waste plastic in bitumen increases the properties of aggregate and bitumen.



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