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Simulation for Modified Bitumen Incorporated with Crumb Rubber Waste for Flexible Pavement

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Abstract*:* This research paper specifies on modified bitumen using recycled plastic waste and crumb rubber for sustainable usage of flexible pavement construction. In current scenario flexible payments fail mostly due to cracking and fatigue in localized areas which decrease the duration of life of the pavement thereby reducing the indented purpose. So this paper focuses on providing an alternative to the already present normal bitumen in flexible pavements thereby reducing landfill problems, increase in efficiency, reducing the usage of raw materials thereby providing a better alternative. The major cause of failure in flexible pavements is defined by localized depression or settling locally. To overcome this problem this research paper focuses on adding additives such as recycled plastic and crumb rubber for reducing the localized failure occurrence. These additives are added at the rate of 2%, 4%, 6%, 8%, 10% for both recycled plastic and crumb rubber to find the mix ratio at which shear strength and ductility is highest for the modified bitumen. Ductility test and shear resistance test are performed in the laboratory to verify the results and provide the necessary information. It is concluded from this study that addition of HDPE and crumb rubber showed a significant increase in durability properties of the binder.

***Keywords*:** *crumb rubber, additives*

1. Introduction

Due to increase in population and urbanization Resources and raw materials are getting scarcer than ever before. The accumulation of waste materials poses a serious challenge to the modern urbanized society. Currently there is no robust recycling program present in our country municipality and town levels. More over the wastes are only dumped as landfills which causes toxic fumes and air pollution for the people around that area, So to reduce the effect of this problem is to recycle certain portion of the waste such as HDPE crumb rubber and to mix them with bitumen to improve the durability and resistance of flexible pavements thereby reducing the bitumen usage in flexible pavements.

Currently the majority of flexible pavements are constructed using normal bitumen which is of conventional grade. The economic, social development and faster transportation relies heavily on Road transportation Infrastructure. So there is a major need for the usage of modified polymer based bitumen by adding additives in bitumen to increase the physical properties of bitumen. This normal bitumen creates a new problem for flexible pavements failing prematurely due to high temperature and cyclical duration of loading. The ministry of transportation has also advised to use polymers as additive to the normal construction grade bitumen. Hence this paper serves as a research bridge for finding modified bitumen of low cost and high durability.

The solution proposed in this paper is to add additives which are durable to be incorporated in to bitumen to increase the rheological properties of the bitumen. The material which is best suitable for steel replacement is bamboo. A widely known fast renewable resource and economical. The current analysis is experimental and mainly focuses on how we can expand the usage of bamboo as a reinforcement material in all construction practices.

Current research focuses on mainly plastic Components as an additive to increase the properties of bitumen to increase the life span of flexible pavement. This paper is focused on mixing waste products in bitumen to reduce landfills. Our research is mainly focused in improving the rheological properties

2. Materials and Procedure

2.1 Materials:

Bitumen 30/40 is obtained from a local oil refinery. Waste materials to be used as additives are dried, cleaned, powdered and then added at 2,4,6,8,10% by the weight of

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the bitumen. The particle size is maintained at 0.15mm to 0.6mm.

Table 1

Physical property	Base bitumen	HDPE	Crumb Rubber
Specific gravity	1.023		
Penetration	57.14	127	
Softening point	48.63	Density=945Kg/m	Density=684Kg/m
Ductility(mm)	122.4		

2.2 Procedure

2.2.1 Sample preparation

HDPE & crumb rubber were mixed with base bitumen for two hours at a steady state temperature of 165°C. Dynamic shear Rheometer test was conducted on virgin binder and with modified binder to determine the physical properties.

2.2.2 Dynamic shear Rheometer test:

It is a test used to determine rheological properties of binders. Virgin binder and modified binder were tested using this machine. Fig 1 shows the Rheometer machine. All tests were conducted at a single frequency with varying temperatures (52-75°C) to test the practical field and also to determine the softening point. The picture of the softening point is shown in Fig 2.

Fig 1: Ductility test

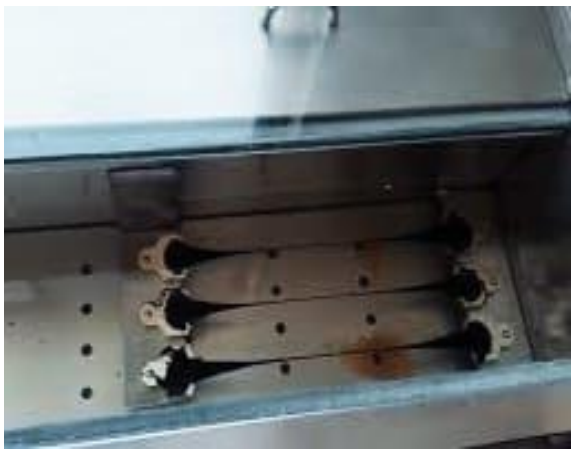

Fig 2: Rheometer

2.2.3 Ductility test:

The ductility test is used here is to measure the ductility of the given sample of modified bitumen. In flexible pavement design it is required that binder should form a thin film around the aggregates by interlocking. So it is very important to test the ductility of the modified bitumen. In this test the ductility is measured in centimetres to which it will elongate before breaking.

For the experiment the bitumen test material of grade 30/40 mixed with additives is poured into the mould assembly on the brass plate. After 25-30 minutes the plate assembly is immersed in water bath. The temperature is maintained at 27°C for half an hour. The sides of the mould are removed and the machine is started and the clips are moved horizontally at a speed of 50mm

per minute. The final point at which the modified bitumen specimen breaks is noted. The results are compared with the normal virgin bitumen. This corresponds to the ductility of the modified bitumen.

3. Results and Discussion

3.1 Results

Temperature plays a huge role in the testing of binder. Therefore the tests were conducted to determine the effects of difference in temperatures to the modified bitumen.

MODIFIED BITUMEN HDPE

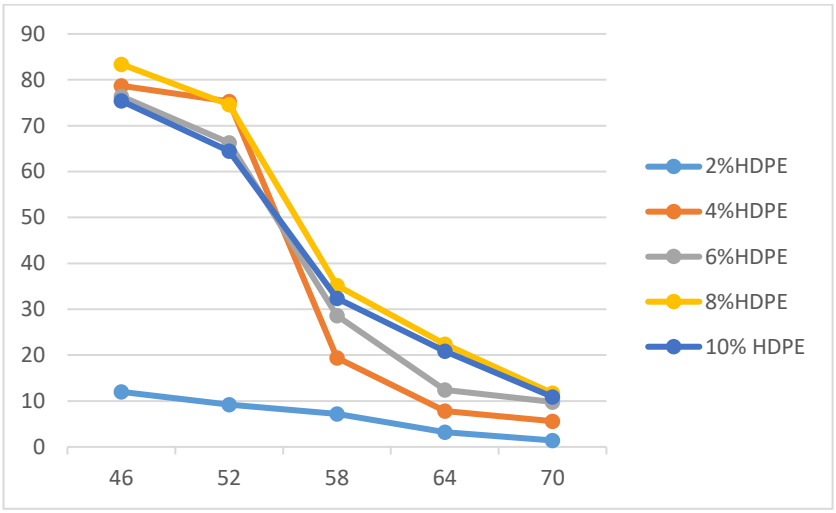

Fig. 1

MODIFIED BITUMEN CRUMB RUBBER

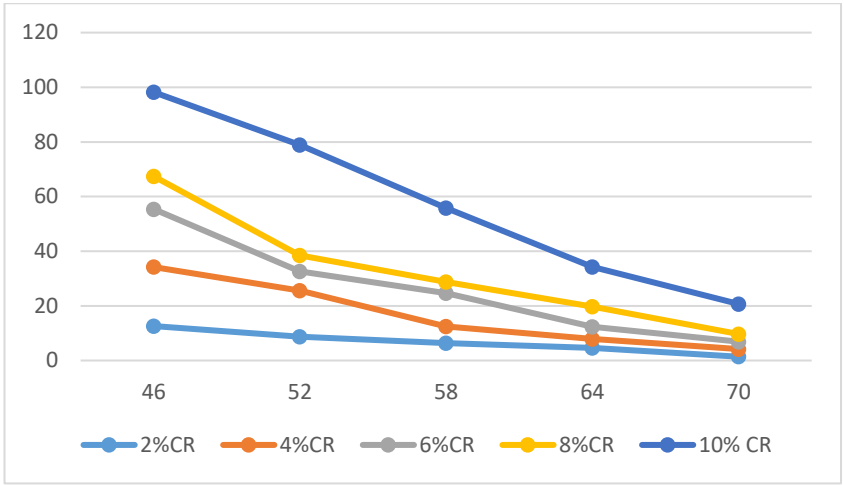

Fig. 2

The test consisting of dynamic shear Rheometer is used to determine the shear modulus and phase angle of the modified binder whicare the main requirements for durability tests in bitumen.

4. Conclusion

We can infer from the results produced in this research it proves that increasing percentages of HDPE & crumb rubber in bitumen has a significant improvement in the elastic & durability behaviour of the modified bitumen.

As a result it can be concluded from this research that addition of plastic wastes and crumb rubber to virgin binder can improve the viscoelastic behaviour of the bitumen. This is a path in the right way for constructing sustainable flexible pavements there by reducing environmental impacts.

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