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Bio-Bitumen

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Abstract - *With increased worldwide worries about the depletion of renewable resources such as petroleum products, greater attention is being placed on bio-based alternative research and use. To address this, bio-fuel production is underway, with fuels derived from organic waste materials and processed for use in a variety of industries. Bio-mass is the name given to this biological waste. A pyrolysis process is utilized to transform this bio-mass into bio-fuels. Pyrolysis is a method that produces biofuels by heating organic matter or biomass to temperatures exceeding 400°C in the absence of oxygen in a reactor or furnace. Other by-products such as bio-char and bio-gases are produced as a result of this procedure. The bio-char obtained is a carbonaceous substance in its entirety. However, in the last decade, no significant attempt has been made to use biochar in pavement applications, particularly as a bio-modifier for asphalt binders. The carbonaceous bio-char obtained during bio-fuel generation through pyrolysis of sawdust, walnut shell powder, and crop straw waste was evaluated as an asphalt modifier/extender to obtain bio-bitumen in this study. The characterization of bitumen binders treated with various amounts of biochar was then carried out (0 percent , 5 percent , 10 percent , 15 percent , and 20 percent by weight of binder). Bio-bitumen (partially replaced by bio-char) was examined and compared to bitumen in terms of consistency, temperature susceptibility, and ductility. To arrive at a conclusion for the above criteria, tests such as penetration, softening point, ductility, and flash and fire point tests were carried out and their findings examined. The addition of bio-char enhanced the temperature resistance, according to the tests. The use of bio-char as a bitumen modifier makes it a potential option, especially in India's hot tropical climate. The use of bio-char to partially replace and modify bitumen helps to address the problem of waste creation from various organic sources. It also provides a commercial benefit for its use in a non-renewable product modification that is a driving force behind the expansion of the world's transportation and highway infrastructure networks.*

Key Words: **Bio-char, Pyrolysis, Bitumen**

1. INTRODUCTION

Bitumen is utilized all over the world as a binder in the creation of flexible pavements. The use of bitumen for pavement construction has a number of negative consequences, including environmental consequences, depletion of petroleum reserves, price spikes, and so on. Bio-bitumen has proven to be a successful strategy for generating a bio-based renewable technology in which bitumen may be partially replaced and modified by a carbonaceous matter such as bio-char. Bio-char, bio-oil, waste cooking oil, plastic, tyre-rubber, polymer, and other materials may be used as an addition to bitumen or to reduce the quantity of bitumen in the binder mixture.

Because of its carbon composition and form, bio-char, a carbonaceous by-product obtained by converting plant matter to bio-fuels by pyrolysis, effectively changes some properties of bitumen. In this study, bio-char is added to bitumen in the binder mixture to act as a partial substitute.

1.1 OBJECTIVES

- To study various properties of bitumen.
- To prepare bio-char from waste materials.
- To evaluate the effect of bio-char addition on the basic properties of bitumen.
- To compare the results obtained from bio-char modified bitumen with the standard performance of absolute bitumen.

1.2 SCOPE

- Studying the properties of absolute bitumen.
- Producing bio-char from waste materials.
- Studying the properties of produced bio-char.
- Preparing bio-char modified bitumen in different proportions.
- Testing and comparing the properties of absolute bitumen and bio-char modified bitumen.

2. REVIEW OF LITERATURE

2.1

Mohammad, L. N., et al. (2013) In this work, the author had performed comprehensive laboratory evaluation of asphalt mixtures containing bio-binder technology at a content of 20%, 25.5%, 30%, and 50%. Laboratory testing was done to evaluate the rutting performance, moisture resistance, and fracture resistance of the produced mixtures**.**

2.2

Zhao, S., et al. (2014) In this research work, the performance of hot-mix asphalt modified by one type of

pyrolytic bio-char with controlled production parameters was evaluated. The bio-char evaluated in this work was an effective modifier in reducing the temperature susceptibility of the binder and increased the rutting, moisture, and cracking resistance of hot-mix asphalt.

2.3
Zhao, S., et al. (2014) In this work, fractionated bio-char, a carbonaceous co-product from bio-fuel production, was utilized as an asphalt modifier. It was found that bio-char was capable of significantly increasing the rutting resistance of the asphalt binder.

2.4
Zhao, S., et al. (2014) In this study, bio-char derived from switch grass through different types of pyrolysis was tested as bio-modifier for asphalt binder. The bio-modifier in this work proved to be more effective asphalt modifier than the commercially available activated carbon with high surface areas.

2.5
Aziz, M. M. A., et al. (2015) This research work stated the necessity of alternatives for bitumen as a binder. The different bio-oils and their comparative behavior when used as a binder in flexible pavement was also discussed.

2.6
Celoglu, M. E., et al. (2016) Walnut shells and apricot seeds were used for modification of bitumen after pyrolysis process in this research work. Penetration test, softening point test, viscosity test and DSR test was performed to obtain the results.

3. METHODOLOGY

The first step is selection of bio-mass or organic material. Bio-mass is selected such that it is a waste product, it is organic in nature, it can grind finely and that it can be subjected to pyrolysis. Based on these requirements, the materials selected for the preparation of bio-char are:

Walnut shell powder
Wood waste
Crop straw (rice husk)

After the selection of bio-mass, it is reduced in size by finely grinding it to form powder and is passed through a 75-micron sieve. The material that passes the sieve is used for further process in the preparation of bio-char.

The fine powder is then dried in an oven at a temperature of about 100°C. After drying, it is then subjected to pyrolysis process of heat treatment. For pyrolysis, the material is placed in a muffle furnace and an oxygen deficit condition is created thereby heating it at a temperature of about 450°C for two hours.
The final product thus obtained is bio-char which acts as a partial replacement and modifier of bitumen.

Preparation of bio-char modified bitumen called as bio-bitumen is done by high-speed shear mixer method. Initially, the base bitumen is heated at a temperature of 150°C.

Then, the prepared bio-char is mixed with bitumen in required proportions for the preparation of samples and their testing. Mixing is done at 130°C-150°C temperature for at least thirty minutes.

Bio-bitumen was then kept in an environmental box for six hours. Penetration test, softening point test, flash and fire test and ductility test is then conducted to check its suitability, to determine the optimum dose and other additional properties.

TESTS CONDUCTED

- Penetration test
- Softening point test
- Ductility test
- Flash and fire point test

4. RESULTS AND ANALYSIS

Table -1: Test Results

Test	0%	5%	10%	15%	20%
Penetration Value (mm)	64.445	37.222	25	19.222	15.778
Softening Point (°C)	32.5	47.5	49.135	54	63
Ductility Value (cm)	>75	36.667	15.667	11.2	7.6
Flash Point (°C)	276	318	325	360	>360
Fire Point (°C)	310	320	338	>360	>360

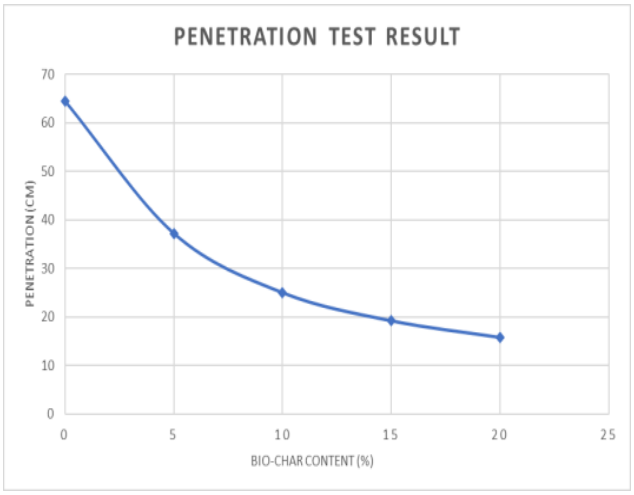

Chart -1: Penetration test

Chart -2: softening point test

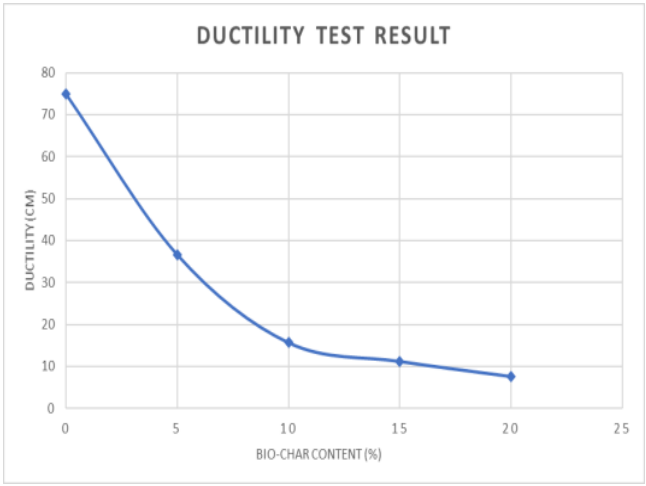

Chart -3: Ductility Test

Fig -1: Bio-char

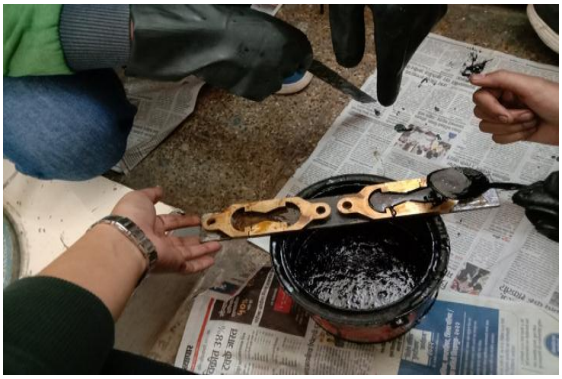

Fig -2: Bio-Bitumen

5. CONCLUSIONS

Bio-char of materials like waste walnut shell powder, sawdust obtained from furniture and wood waste, crop straw from farm waste and packaging solid waste was produced by method of pyrolysis in muffle furnace at a very high temperature in the absence of oxygen. Various physical properties such as Penetration Test , of bio-char modified bitumen were studied and analyzed for different percentage of bio-char content. Tests such as penetration test with penetrometer, softening point test by ring and ball apparatus, ductility test by using ductility machine and flash and fire point tests were performed on given specimens to study parameters such as temperature susceptibility for warmer regions, rutting resistance, consistency and ductility. The results obtained showed decrease in penetration values and ductility as bio-char content increased. There was an increase in softening point and flash and fire points as the content of bio- char increased. This indicates that temperature susceptibility has increased as softening point increased along with increase in stiffness as penetration value decreased. Increase in stiffness reduced rutting action and formation of depressions.

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