

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 4, April 2018

Experimental Study of Effects of Cigarette Butts in Bitumen Mix

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ABSTRACT: This paper is written on the experimental study done on encapsulated cigarette butts with bitumen mix. India has a smoking population of 120 million people. According to recent internet studies, cigarette consumption per capita is 110.93. Hence, waste of cigarette butt is on the larger scale. This paper throws some light on a method of reusing the cigarette butts in the bitumen mix, although cigarette butts are the most common litter found around the world, also the encapsulation of the cigarette butt is done before using it in the mix, encapsulation is necessary because it prevents mixing of the toxic materials or any other chemical present in the cigarette mix. Encapsulation of cigarette butts is done in two ways, encapsulation with bitumen VG30 grade and encapsulation with paraffin wax. All samples, including the control mix were tested for the stability and flow. The compressive strength of the modified mixes was decreased as compared to the control mix moulds. The positive point from the experiment was that the additional coat was added to prevent water leakage into the roads. The usage of cigarette butts reduced the waste of butts.

KEYWORDS: Bitumen, Cigarette Butts, Encapsulation, Wax.

I. INTRODUCTION

India being a developing country has a population of 135.4 crores with average consumption of cigarette butt per person being 110.93 per year. The total cigarette consumed per year is 132 crores. Cigarette butts or cigarette filters are manufactured from synthesised fibres called as cellulose acetate. It takes around 10 months to 10 years to decompose depending upon the environmental factors. Hence to reduce the waste produced by the cigarette butts we proposed to use the cigarette butts in the bitumen mix. The mix chosen by us was the Dense Bitumen Macadam mix. India having 2nd largest road network also helps to efficiently reuse and reduce the waste produced by the cigarette butts. This report involves two investigations, first involves assessing the effect of incorporating different amounts of cigarette butts into a DBM mix manufactured with VG30 grade of bitumen and encapsulation of cigarette butts with bitumen of grade VG30. The second investigation involves encapsulation of cigarette butts with wax and incorporating into DBM mix.

II. RELATED WORK

This particular section discusses the related work done on this particular topic. In this paper "A practical proposal for solving the world's cigarette butt problem: Recycling in fired clay bricks" by Abbas Mohejeran and team have incorporated cigarette butt in clay bricks they have added the cigarette butts 2.5%, 5%, 7.5% and 10% by weight. They have concluded that by increasing the concentration of cigarette butts the compressive strength of clay bricks decreases. They have also concluded that 1% of cigarette butt by weight would be appropriate^[1]. The paper "Potential use of cigarette filter as sound porous absorber" by Ruben Maderuelo-Sanz and team have used cigarette butt as a sound absorber. They have concluded that the cigarette butts can be used as sound porous absorber and can compete

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with commercially available acoustical products [2]. The paper “Developmental toxicity of cigarette butt- An underdeveloped issue” by Wenjau Lee and Chih Chun Lee have explained that the development of toxic cigarette butt effect the public health. This can lead to leaching. This paper provides the clear evidence that the cigarette butt is hazardous material for environment and human health [3]. The paper “Effect of bitumen wax on asphalt mixture performance” by Xiaohu Lu and Per Redelins has concentrated on waxes which are naturally present in the bitumen. The main objective was to study the rheological effect of bitumen wax and impact of the same. They have concluded that rheological properties of bitumen are not affected by wax content [4]

III.METHODOLOGY

The aggregate and bitumen were tested to check the quality of the same. Tests like aggregate impact test, shape tests, water absorption test and specific gravity tests were carried out on aggregates. Tests like ductility test, softening point test, penetration test were carried out on bitumen. Moulds were tested for Marshals Stability test.

IV.EXPERIMENTAL RESULTS

A. Encapsulation of cigarette butt with bitumen

Cigarette butts were collected from various sources. The cellulose acetate (cigarette butts) and waste materials (paper and tobacco) were separated. Prior to mould making of Dense Bitumen Macadam mix the cigarette butts were allowed to stay in the melted bitumen to encapsulate them. Encapsulation is done to prevent the contamination of bitumen from harmful and toxic chemical present in the cigarette butts.



Fig1: Cigarette butts placing in the oven at 105°C for 24 hours

Figure 1 shows that cigarette butts are being placed in the oven at 105 °C for the period of 24 hours in order to remove the moisture present in the cigarette butts. This helps to encapsulate the cigarette butt without any voids.



Fig 2: Cigarette butts encapsulated with bitumen left to cool

The butts were kept in the bitumen for 5-10 min to completely soak them into bitumen. The butts then were removed from the bitumen and kept aside to use them in the mix. Figure 2 shows that the encapsulated cigarette butts were placed on paper and left to cool for 5 min.

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B. Encapsulation of cigarette butt with paraffin wax

Same procedure was followed for the encapsulation of cigarette butt with paraffin wax.



Fig 3: Cigarette butts soaked in wax

Figure 3 shows that cigarette butts are submerged in heated paraffin wax. The cigarette butts were pressed against the bottom and side of the pan in order to remove any air that may be trapped inside the cigarettes butts.



Fig 4: Cigarette butts encapsulated with wax cooled

Figure 4 shows wax encapsulated and cooled cigarette butts. The encapsulated and cooled cigarette butts were rolled in the sand and sieved to remove any remaining wax from the surface.

C. Mould Preparation

The aggregate and bitumen required for the study was provided by Pune Municipal Corporation Hot Mix plant, Yerawada. The following mix formula was used for DBM mix preparation.

| | | |
|---------------------|----------------|--------|
| Bitumen VG-30 grade | 4.3% by weight | 52 gm |
| | 4.5% by weight | 54 gm |
| | 4.7% by weight | 57 gm |
| 20 mm aggregate | 42% by weight | 504 gm |
| 10 mm aggregate | 0.8% by weight | 96 gm |
| 06 mm aggregate | 0.8% by weight | 96 gm |
| Crush Sand | 40% by weight | 480 gm |
| Filler (Stone Dust) | 2.0% by weight | 24 gm |

Table 1: Dense Bitumen Macadam mix Formula

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The aggregates and bitumen were mixed and the placed in the mould. The quantity of cigarette butts were added was 6 grams, 8 grams, 13 grams. 3 moulds of each were casted for bitumen encapsulated and wax encapsulated. The optimum content of bitumen was also found out. Hence in total 27 moulds were casted.



Fig 5: Mould being casted

Figure 5 shows prepared DBM mix is being poured into the marshal stability mould, before casting of mould all testing equipment and materials are heated at same temperature.

D. Testing

The moulds casted were compacted with 75 blows on each side by automatic marshal compactor machine.



Fig 6: Automatic Marshal Compactor Machine

Figure 6 shows automatic marshal compactor machine. Then the moulds were removed after 24 hours and then paced in the water bath at 60°C for 30 minutes. This was done to simulate the seasons endured by the mix. The moulds were removed from the water bath and were tested for Marshal Stability Test.

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Fig7: Mould being tested for Stability and flow

Figure 7 shows marshal stability testing equipment, after assembly of mould in equipment a load was gradually apply to the specimen until the load begin to decreases, then the maximum load (stability) reading and flow reading were recorded.

V. RESULT

| Percentage of Bitumen | Divisions | Stability(kg) | Flow(mm) |
|-----------------------|-----------|---------------|----------|
| 4.3% | 235 | 1026.72 | 3 |
| | 240 | 1048.56 | 3.5 |
| | 230 | 1004.87 | 3 |
| 4.5% | 260 | 1135.94 | 3.5 |
| | 265 | 1157.79 | 4 |
| | 260 | 1135.94 | 3.5 |
| 4.7% | 250 | 1092.25 | 4.5 |
| | 245 | 1070.41 | 3.5 |
| | 255 | 1114.41 | 4 |

Table 2: Test results of bitumen

The above table mentions the test results carried on control moulds by adding 4.3%, 4.5% and 4.7% of bitumen by weight (1200 grams). It is seen that the optimum content of bitumen is 4.5% as it achieves the greater stability. The flow is also in range and hence it is safe to use.

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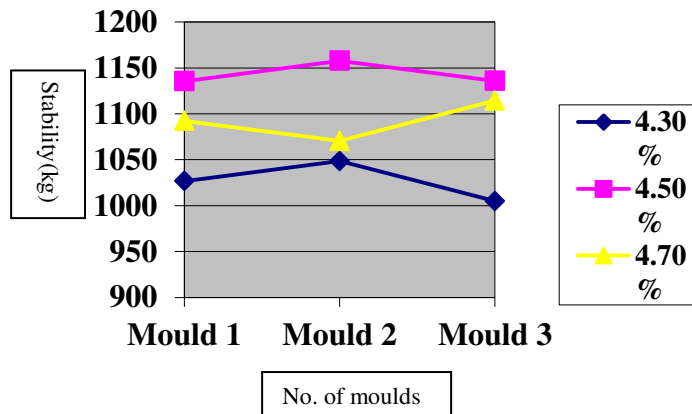


Fig8: Graphical representation of result of bitumen

This graphical representation clearly shows the optimum content of bitumen i.e. 4.5% by weight. The optimum amount is 4.5% by weight.

| Weight of cigarette butts | Divisions | Stability (kg) | Flow(mm) |
|---------------------------|-----------|----------------|----------|
| 6 grams | 230 | 1004.87 | 3 |
| | 255 | 1114.41 | 3 |
| | 245 | 1070.41 | 3.5 |
| 8 grams | 245 | 1070.41 | 3.5 |
| | 260 | 1135.94 | 3.5 |
| | 255 | 1114.41 | 4 |
| 13 grams | 240 | 1048.56 | 4.5 |
| | 250 | 1092.25 | 4 |
| | 235 | 1026.72 | 5 |

Table3: Results of bitumen mix with encapsulated cigarette butts with bitumen

The above table shows the result of bitumen mix with encapsulated cigarette butts with bitumen. It is seen that the optimum amount of cigarette butt is 8 grams as it achieves the maximum stability and flow is also desirable.

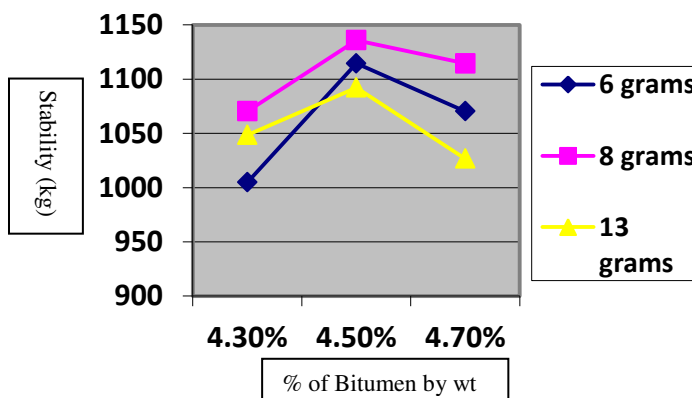


Fig9: Graphical representation of result of bitumen mix with encapsulated cigarette butts with bitumen

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The results show that 8 grams with 4.5% by weight of bitumen gives maximum stability and optimum flow which can be used for the practical purposes.

| Weight of cigarette butts | Divisions | Stability (kg) | Flow(mm) |
|---------------------------|-----------|----------------|----------|
| 6 grams | 220 | 961.87 | 3.5 |
| | 240 | 1048.87 | 3 |
| | 230 | 1004.87 | 3.5 |
| 8 grams | 240 | 1048.56 | 3.5 |
| | 255 | 1114.09 | 3.5 |
| | 250 | 1092.25 | 4 |
| 13 grams | 240 | 1048.56 | 4.5 |
| | 245 | 1070.405 | 4 |
| | 240 | 1048.56 | 6 |

Table3: Results of bitumen mix with encapsulated cigarette butts with paraffin wax

The above table shows the result of bitumen mix with encapsulated cigarette butts with paraffin. It is seen that the optimum amount of cigarette butt is 8 grams as it achieves the maximum stability and flow is also desirable.

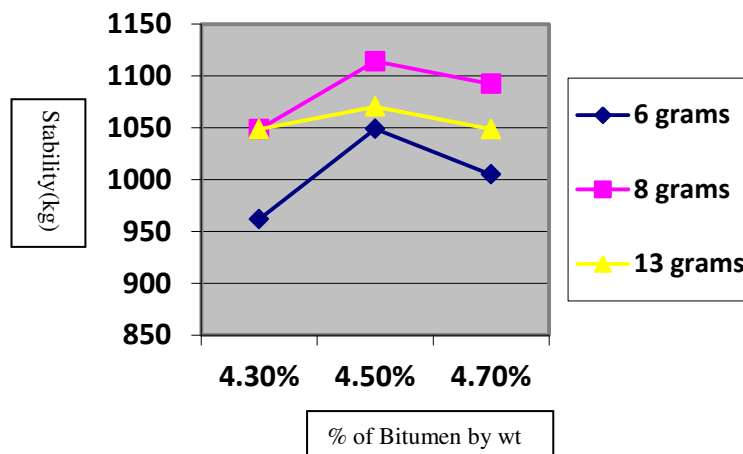


Fig10: Graphical representation of result of bitumen mix with encapsulated cigarette butts with paraffin wax

The results show that 8 grams with 4.5% by weight of bitumen gives maximum stability and optimum flow which can be used for the practical purposes.

VI. CONCLUSION

The purpose of this study was to encapsulate used cigarette butts for the incorporation into dense bitumen macadam. Different percentages of bitumen were used in Dense Bitumen Macadam in order to determine how the use of different percentage of bitumen would offer the properties of Dense Bitumen Macadam. Several tests were carried out in accordance with the relevant standards to determine the mechanical properties of Dense Bitumen Macadam. This was done for both investigations involving encapsulation with bitumen and encapsulation with paraffin wax. The investigation shows that as the percentage of cigarette butt increases the stability decreases. Flow values for all samples except few samples were within the permissible limits. Stability of samples was more than the stability given in

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standard norms. Further investigation is recommended for bitumen and paraffin encapsulation of cigarette butt and application of encapsulated cigarette butt in dense bitumen macadam and other type of construction material.

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