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MODIFICATION OF BITUMEN WITH SUGARCANE MOLASSES AND COCONUT SHELL CHARCOAL

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Abstract – *Because of increase of energy cost, the need for improvement of pavement quality as well as concern over pollution and alternative binders are needed to modify partially or totally replace bitumen. The benefits of using alternative binders are that they can save the natural resources and reduce energy consumption. This paper is intended to for the modification of bitumen with sugarcane molasses, coconut shell charcoal (CSC) and combination of molasses and CSC. Molasses is a waste from sugar production and CSC is a product of coconut shell. Because of urgent need of infrastructure, rehabilitation and maintenance, introduction and application of such environment friendly materials like sugarcane molasses and CSC are required. Molasses, CSC and their combinations are added to bitumen at various percentages. Various tests for bitumen like Viscosity test, Specific Gravity test, Ductility test, Softening test are conducted to find out the optimum percentage for modification of bitumen. Penetration test are also conducted for optimum percentage obtained.*

Key Words: **Bitumen, Sugarcane molasses, Coconut shell charcoal, Environment friendly, Modification, Alternative binders**

1. INTRODUCTION

The world has become increasingly concerned over the global climatic change thought to be caused by the greenhouse gases, chief among them anthropogenic carbon dioxide which is released into the atmosphere from burning carbon fuels. This has led into the introduction of bitumen alternatives that are more environmental friendly and non - toxic.

Molasses are the end product of the sugar manufacturing process and once no more sugar can be crystallized from the raw crop, the residual product is molasses. Molasses is used in diverse range of industries due to its excellent non - binding properties. It has an advantage over other binding materials such as tar and lignin sulphonate as it does not produce a toxic emission on combustion instead much safer for the environment. In addition as a liquid it is easy to handle and incorporate into various manufacturing process.

Coconut shell charcoal is also considered as a waste modifier. CSC produces activated carbon. Activated carbon is a non-graphite form of carbon that is usually found in carbonaceous material, such as CSC. The CSC is a potential material because of its high strength and modulus properties along with the added advantages of lignin content. The shell is similar to hard wood in chemical composition. The high lignin content renders the modified asphalt using CSC more weather resistant and hence more suitable for application as a construction material.

2. EXPERIMENTAL STUDY

The experimental study aims at investigating the optimum percentage for modification of bitumen with the locally available waste materials. Bitumen, extensively used for the construction of asphalt pavements is of high cost and releases huge amount of toxic gas carbon dioxide into the atmosphere. Due to these drawbacks of bitumen led to the idea of an experimental investigation of modification of bitumen with sugarcane molasses, CSC, and combinations of these two. On direct field visit we observed that molasses from various sugar factories are being discharged into the rivers without any purification making the receiving water bodies polluted. So we collected molasses from Kerafed kollam Unit for the experiments. The coconut shell is considered as an agricultural waste, so we collected coconut shell and is converted into charcoal for the modification of bitumen. We also conducted the combinations of both sugarcane molasses and coconut shell charcoal for the modification.

3. SAMPLE COLLECTION AND TEST RESULTS

The various materials collected for our work are briefly mentioned below.

3.1 BITUMEN

Bitumen of grade VG – 30 was collected from PWD Attingal section for the entire work and basic test like Viscosity, Specific Gravity, Softening, Ductility were conducted.

Table- 1: Test results of bitumen

TEST	RESULTS
Ductility	70cm
Specific Gravity	1
Softening	44.5°C
Viscosity	26 sec

3.2 COARSE AGGREGATE

Coarse aggregates were collected from crusher unit Paripally and conducted the basic tests like Specific Gravity, Water Absorption, Los Angeles, Crushing value, Impact value, Shape test.

Table- 2: Test results of aggregate

TEST	RESULTS
Impact value test	27%
Crushing value test	25%
Los angeles abrasion test	34%
Shape test 1.Elogation test 2.Flakiness test	 15% 14%
Specific Gravity	2.6

3.3 MODIFIERS

The materials used for modification of bitumen are molasses and coconut shell charcoal. The sugarcane molasses were collected from Kerafed Unit Kollam and the CSC were collected from various agricultural farms.

4. DETAILS OF EXPERIMENT

The experimental program consists of preparation and testing of bitumen with molasses, CSC and combinations of these two at various percentages. The various tests like viscosity, specific gravity, softening, ductility were conducted for all the percentage and obtained the optimum percentage for molasses, CSC and combinations of both molasses and coconut shell charcoal. Penetration test were conducted for obtained optimum percentage. The optimum value obtained can be taken for the modification of bitumen with the locally available waste materials collected.

5. METHODOLOGY

5.1 OPTIMUM PERCENTAGE OF SUGARCANE MOLASSES

The bitumen is modified with sugarcane molasses at various percentages ranging from 1% to 15% and tests were conducted for all the percentages to obtain the optimum percentage. The test results were shown in the table below.

Table- 3: Test results of bitumen with molasses

Percentages	Ductility (cm)	Softening (°C)	Viscosity (sec)	Specific Gravity
1	76	46	23	0.97
2	78	46	23	0.97
3	78	48	26	0.98
4	80	50	25	0.98
5	83	52	26	0.98
6	84	52	26	0.99
7	85	52	28	0.99
8	85	53	35	1
9	85	56	30	1
10	83	60	26	1
11	80	58	26	1.03
12	79	58	26	1.03
13	79	58	26	1.03
14	78	56	25	1.03
15	79	56	25	1.01

The graphs drawn based on the results are shown below:

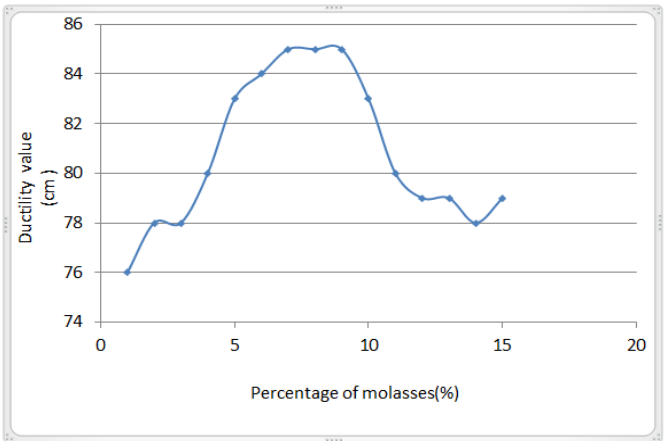

Chart- 1: Graph between percentage of molasses and ductility

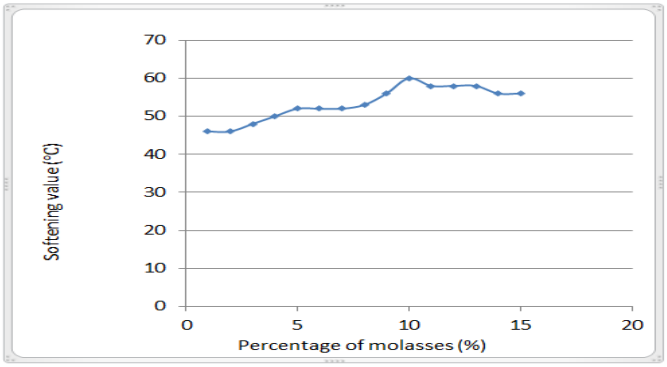

Chart- 2: Graph between percentage of molasses and softening

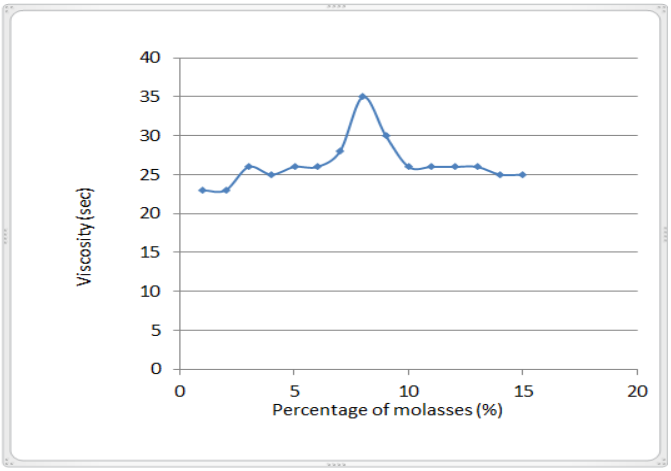

Chart- 3: Graph between percentage of molasses and Viscosity

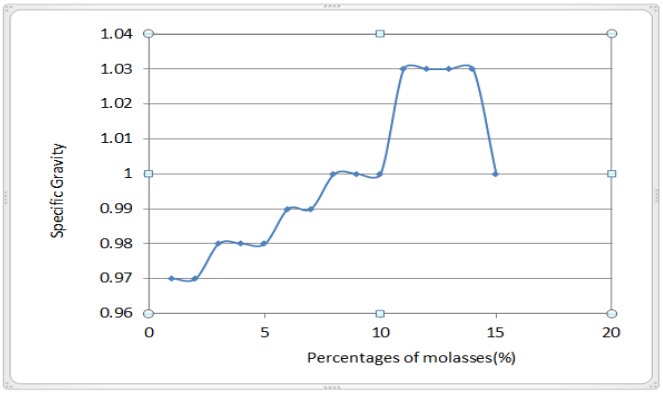

Chart- 4: Graph between percentage of molasses and Specific Gravity

From the table and graphs drawn we can conclude that the optimum percentage is obtained at 9%.

5.2 OPTIMUM PERCENATGE OF COCONUT SHELL CHARCOAL (CSC)

The bitumen is modified with CSC at various percentages like 5%, 10%, 15%, 20%, 25%, 30%, 35% and test were conducted for all the percentages to obtain the optimum percentage. The test results were shown in the table below:

Table- 4: Test results of bitumen with CSC

Percentages	Ductility (cm)	Softening (°C)	Viscosity (sec)	Specific Gravity
5	72	54	23	0.89
10	75	55	25	0.9
15	75	55	26	0.96
20	76	58	26	0.98
25	72	58	25	1
30	72	56	20	0.99
35	70	52	19	0.96

The graphs drawn based on the results are given below:

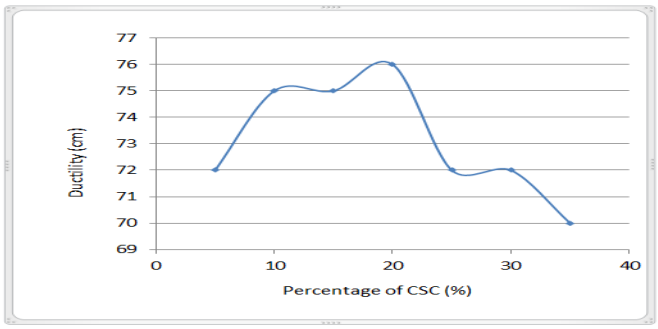

Chart- 5: Graph between percentage of CSC and Ductility

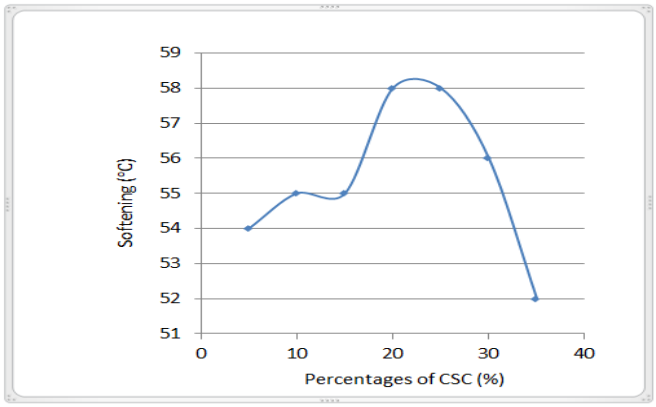

Chart- 6: Graph between percentage of CSC and Softening

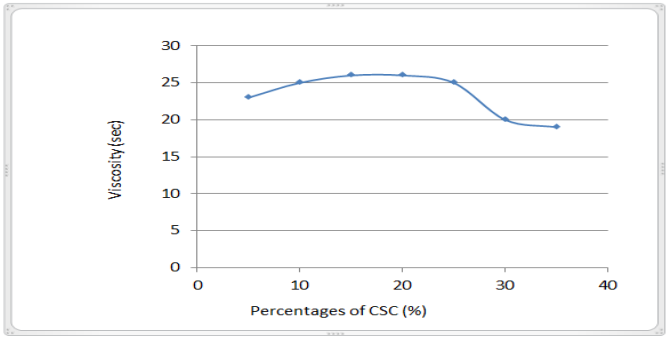

Chart- 7: Graph between percentage of CSC and Viscosity

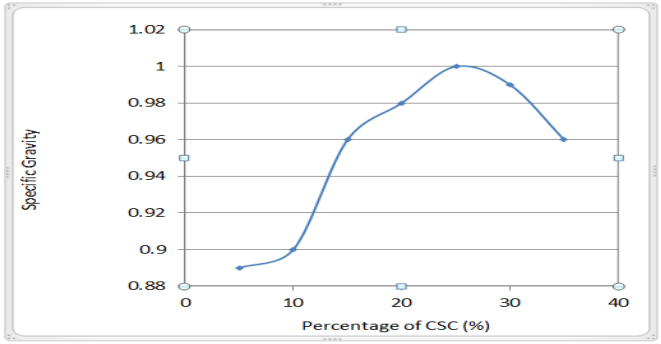

Chart- 8: Graph between percentage of CSC and Specific gravity

From the results and the graph drawn we can conclude that the optimum percentage is obtained at 20%.

5.3 OPTIMUM PERCENTAGE OF COMBINATIONS OF SUGARCANE MOLASSES(SCM) AND CSC

The bitumen is modified with combinations of molasses and CSC at various percentages. The molasses were taken in different percentages like 5%, 6%, 7%, 8%, 9%, 10%, 11% and CSC were taken at percentages like 1%, 2%, 3%, 4%, 5%, 6%, 7% to obtain the optimum percentage for modified bitumen.

Table- 5: Test results of bitumen with combinations

% of SCM	% of CSC	Ductility (cm)	Softening (°C)	Viscosity (sec)	Specific Gravity
5	1	73	52	23	0.97
6	2	75	55	23	0.97
7	3	76	56	26	0.98
8	4	76	56	27	0.99
9	5	73	54	26	0.95
10	6	71	50	23	0.93
11	7	69	47	19	0.92

From the results and graph obtained we can conclude that the optimum percentage was obtained at 8% of molasses and 4 % of CSC.

5.4 PENETRATION VALUE

- Penetration value for modified bitumen with molasses = 135
- Penetration value for modified bitumen with CSC = 128
- Penetration value for modified bitumen with combinations = 132

6. RESULTS AND DISCUSSIONS

- The optimum percentage of molasses as modified bitumen is 9%.
- The optimum percentage of CSC as modified bitumen is 20%.
- The optimum percentage of combination of molasses and CSC as modified bitumen is 8% of molasses and 4% charcoal.

7. CONCLUSION

From the study of the behavior of molasses modified bitumen shows that the bitumen can be modified with molasses up to an optimum percentage of 9%. This optimum percentage shows considerable increase in the values of basic properties of bitumen. The behavior of CSC modified bitumen shows that the bitumen can be modified up to an optimum percentage of 20%. By the experiments on combination of molasses and CSC to modify bitumen the optimum percentage obtained is at 4% CSC and 8% molasses. Molasses proves to have better rheological properties compared to CSC and combinations as it shows considerable increase in the value of ductility, softening, viscosity etc. Hence molasses can be used as a better substitute for bitumen.

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BIOGRAPHIES

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