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Feasibility Study of Sugarcane Waste Molasses in Stone Matrix Asphalt

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ABSTRACT: Nowadays, we are facing several environmental pollutions. In the construction of road work bitumen is the main content. Production of bitumen causes huge quantity of CO₂. It will cause global warming or higher temperature. In sugar refining industry, the major byproduct is molasses. Sugarcane waste molasses will replace bitumen. So as usage of waste molasses will reduce the production of bitumen content. It will reduce the effects of global warming. In this research we will introduce different dosage of molasses with bitumen and conduct various transportation engineering laboratory test and find out optimum molasses content which will give the same result of same bitumen content. By this investigation it was found that the modified bituminous mix having enhanced and better Marshall characteristics as compared to conventional bituminous mix. The stability value of the Marshall mix increases up to 12% and then decreases. The flow value of the mix gets decreased by the addition of molasses.

KEYWORDS: Biodegradable, bitumen, waste molasses, strength, mixing of molasses and bitumen

I. INTRODUCTION

Stone matrix asphalt is a gap-graded mixture, which gives better strength to the mixture and having better stone to stone contact. In this research, aggregates are used as per IS specifications. The samples are made with different gradations using aggregates, cement and bitumen as filler material. Here molasses are used as stabilizers. Molasses helps to decreasing the drain down and to increasing the strength of mix. The apparatus used for testing the SMA samples is Marshall apparatus. Here comparison of SMA mix with and without molasses is done. A structure called pavement that lies above the natural soil subgrade and which consist of different layers of processed materials. Pavement must withstand the load imposed by the vehicle by transferring it to the subgrade or transmit the stresses imparted by the wheel to the subgrade. There are mainly two types of pavements namely flexible pavements and rigid pavements, each of them having their own pros and cons.

II. MATERIALS USED

2.1 AGGREGATES

Aggregates are basically obtained by crushing naturally occurring rocks. The aggregate property depends upon parent rock which may be igneous, sedimentary or metamorphic. There are mainly two types of aggregates namely coarse aggregate and fine aggregate. Coarse aggregate will retained on 4.75 mm sieve. Fine aggregate will pass through 4.75 mm sieve.

2.2 BITUMEN

Bitumen is generally extracted by fractional distillation of petroleum. Bitumen binder helps proper binding of aggregates with the whole mix. Bitumen is available in various grades, among them 60/70 is most suitable for high volume traffic roads. Bitumen is also waterproofing and adhesive nature material. Bitumen consist of high complex hydrocarbon and it also contains elements such as calcium, iron, sulphur and hydrogen.

2.3 MOLASSES

Molasses is a waste material which is generally obtained in sugar refining industry. Molasses is classified on the basis of percentage of sugar, extraction method, colour range, nutrition content and sweetness. There are different types of molasses available in market. By introducing molasses over the aggregate will increase binding characteristics.



III. RESULTS AND DISCUSSIONS

3.1 MATERIAL COLLECTED

Materials required for this study are the constituents of asphalt and molasses. Aggregates used are of crushed stones, 60/70 penetration grade bitumen, molasses taken from near by sugar refining factory.

3.2 RESULTS FOR AGGREGATE

Aggregate tests such as impact test, losangeles abrasion test, flakiness and elongation test, specific gravity test, water absorption test were conducted as per IS standards. Results are shown in the table given below

Table 3.2 Aggregate test result

SL.NO	PARTICULARS	TEST RESULT	MORTH specification VALUES
1	IMPACT TEST %	14.28	MAX 24%
2	LOS ANGEL'S ABRASION VALUE %	22	MAX 45%
3	FLAKINESS AND ELONGATION INDEX	13.31 & 19.9	MAX 35%
4	SPECIFIC GRAVITY COARSE AGGREGATE	2.76	MAX 2.68
5	WATER ABSORPTION TEST %	0.9	MAX 1%

3.3 RESULTS FOR BITUMEN

Bitumen test such as penetration test, softening point test, flash point test, specific gravity, ductility, viscosity were conducted. The table given below shows the result

Table 3.3 Bitumen test result

Property	VG 30		Code
	Result	Specification	
Softening point(°C)	54	Min 47	IS:1205-1978
Ductility (cm)	90	Min 75	IS:1208-1978



Standard Penetration Value	64.33	50-70	IS:1203-1978
Viscosity (Poise)	2895	3000±600	IS:1206 part II
Flash Point Test	221°C	220°C	IS 73:2006

3.4 MARSHALL METHOD OF MIX DESIGN

Marshall stability and flow value are the test used to find out the resistance to plastic deformation of cylindrical specimen of bituminous mixture and is measured when the same is loaded at a rate of 5cm per minute. Aggregate should be thoroughly sieved and the nominal size of the aggregate is taken as 20 mm to 25mm. weighing of aggregates and filler material is done in such a way that the final mix should have a weight of 1200gm. If we take 20mm as nominal size of aggregates then the sample retained in 20mm sieve should be zero. The bitumen is heated at a temperature of 145 degree Celsius. The cylindrical mold and the aggregates have to be pre-heated in the hot air oven. The bitumen is poured hot in the pre-heated aggregates with correct proportion of 1200gm. The mixing is done thoroughly and the mix is poured into the pre-heated mold. 75 blows are given on each side of the mold with rammer. The rammer should be dropped vertically from the height of 45.7cm. After this the mold is kept for cooling for 24 hours at room temperature. Now the extraction of mold is done by sample extractor, the bearing ball should be kept between the extracting tool and specimen is collected by hitting with the hammer carefully. The mold is kept into the water bath having 60 degree temperature for 20 minutes. Take the submerged weight after 20 minutes. The mold is properly placed in the breaking head and fixes the setup and takes the reading of stability and flow of specimen when the deformation is noticed. After that the tested mold is removed from the machine and average of three istaken.

Table 3.4 showing percentage replacements of molasses with bitumen for checking the effect of molasses on bitumen

Penetration trial with 300gm of sample	Percentage of molasses (%)	Value of penetration Obtained	Penetration range of VG30
100	0	64	60/70
98	2	65.2	60/70
96	4	66.3	60/70
94	6	67	60/70
92	8	68.9	60/70
90	10	79.2	60/70
88	12	82.9	80/100
86	14	88	80/100

The results shown in this table is as per the replacement of bitumen with molasses. The percentage trial starts from 2%, 4% and up to 10% its within the penetration range of 60/70, but when the percentage of molasses exceeds from 10% to



12% and above its showing drastic change in the penetration value of VG30 grade of bitumen corresponding to 80/100 penetration grade which is used as a penetration grade of VG10.

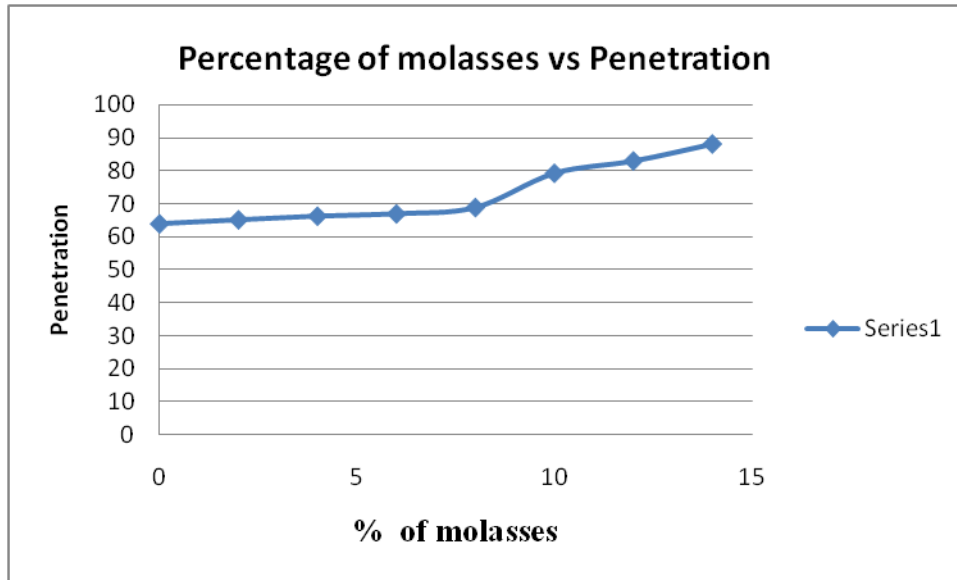


Fig 3.5 penetration vs % of molasses

This graph is plotted between percentage replacement of molasses with respect to the change in penetration grade of bitumen.

From the graph, as the percentage of molasses increases the penetration value gets increases gradually. Molasses does not affects the penetration value at about 7%. The maximum penetration value is obtained at 15%. From this we can conclude that penetration value will increases as the molasses rate increases.

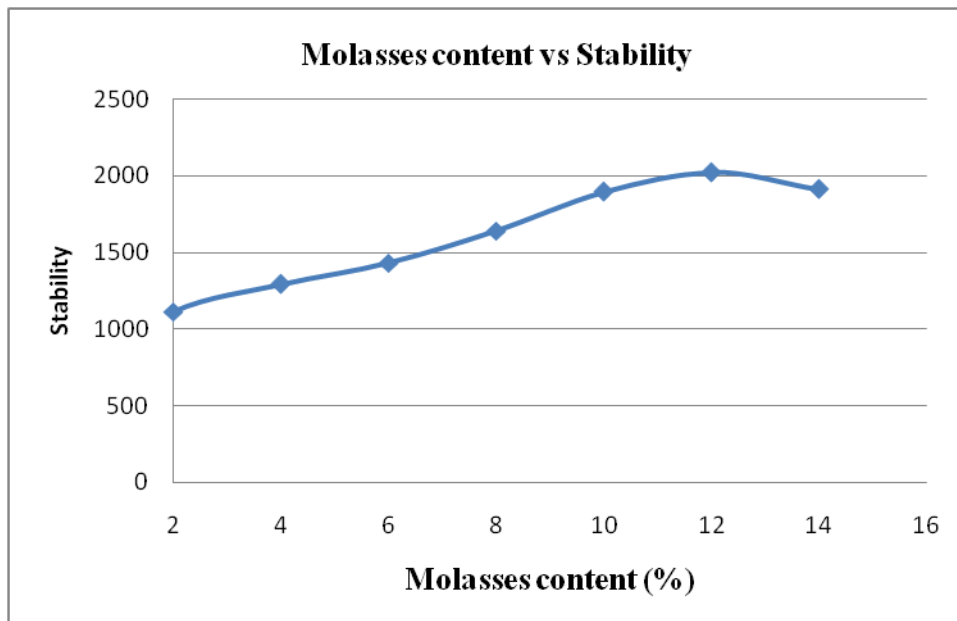


Fig 3.6 Molasses (%) Vs Stability

The above graph is plotted between stability and the molasses content. The stability is taken on y-axis and molasses content is taken on x-axis. The stability is getting increased up to 12% and then goes on decreasing, so we can conclude that by using molasses we can do the partial replacement of bitumen up to 12% and by this strength the life of



bituminous mix design is improved. The highest point in the stability graph is taken as optimum molasses content and because of the increase in the stability the bonding between the aggregate is strong and by this the damage on the pavements will be less.

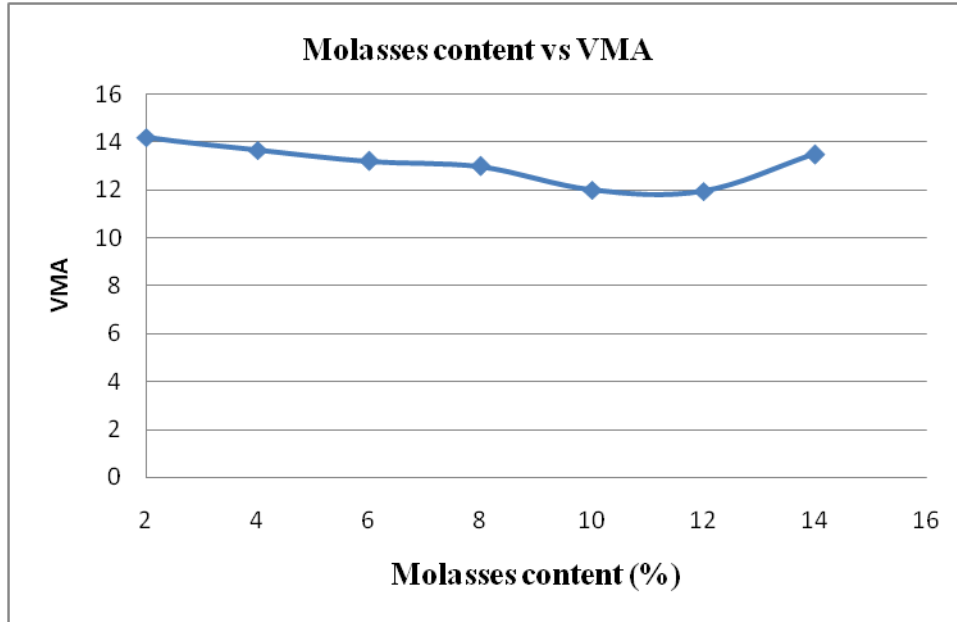


Fig 3.7 Molasses (%) Vs VMA (%)

This above graph is plotted between molasses content and voids filled with mineral aggregates. The value of molasses are plotted on x – axis and the value of VMA is plotted on y-axis. By this graph we can see that the voids filled with the mineral aggregate are getting reduced up to 12% and then gradually increasing as the percentage of the molasses is increased above it. The desirable value of VMA is less than 18% and thus the VMA is decreasing the stability will be increased and this means that the strength is high at 12% and then decreases.

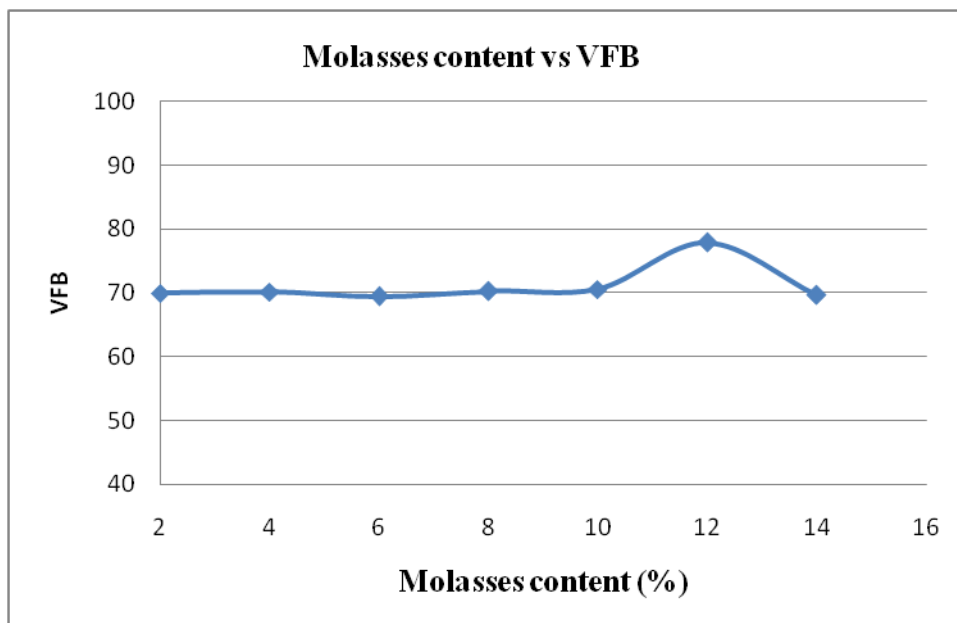


Fig 3.8 Molasses (%) Vs VFB (%)

This graph is plotted between molasses content with respect to the voids filled with the bitumen. The value on the x-axis is the molasses content and the value on the y-axis is voids filled with bitumen. By this graph it can be observed

that the value of voids filled with bitumen should be greater than 75% so that the bitumen mix will be in a good condition. If the voids are properly filled with the bitumen then the bonding between the material of the mix like aggregates, filler will be better .

IV. CONCLUSION

From this above study the behavior of the molasses modified bitumen mix it was found that the modified bituminous mix having enhanced and better Marshal Characteristics as compared to the conventional bituminous mix. It was observed that the stability value of the marshal mix increases up to 12% and then decreases. The flow value of the mix decreases as per the addition of molasses. The other volumetric parameters such as volume of voids (Vv), volume of bitumen (Vb), voids in mineral aggregates (VMA), and voids filled with bitumen (VFB). By addition of molasses in bitumen it was found that up to 10% the value of penetration is within the penetration range of 60/70, but when the percentage of molasses exceeds from 10% to 12% and above its showing drastic change in the penetration value of VG30 grade of bitumen corresponding to 80/100 penetration grade which is used as a penetration grade of VG10. So, we can come to the conclusion that after adding more than 10 percent of molasses in bitumen (VG30) the grade of the bitumen changes from 60/70 to 80/100 which is same as the VG10 grade of the bitumen. So, as per the penetration test, we can relate that the viscosity of the bitumen (VG30) is getting reduced if the molasses is added more than 10% in the bitumen and it is showing the characteristics of VG10 grade of bitumen and the VG30 grade of bitumen losses its actual property. So by this we can conclude that the molasses should be used within the specified limit because if we go beyond that limit the bitumen will lose its actual grade which can lead to various defects of the pavements.

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