Review Paper on The Aftermath of Sugarcane Bagasse Ash As Filler In Bituminous Concrete And Modification of Bitumen With Molasses

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Abstract- *Fly ash, stone dust, rice husk ash and some other waste products such as sugarcane bagasse ash and molasses which are easily available mostly in the state of Punjab and Uttar Pradesh in India. These waste products can be used as fillers in the bituminous mix. With the help of these fillers it can gain the requirements for different physical properties of the mix. In this study the main objective is to find out the optimum bitumen content of the mix and also replacing stone dust by sugarcane bagasse ash as fillers. Replacements can be done in percentage. Normal Sample where stone dust were added as fillers and bitumen content are made in 4%, 4.5%, 5%, 5.5% and 6% and Marshall testing is done to find out the optimum bitumen content, and the outcomes shows that the optimum bitumen content was 5.4%. The main focus in this experiment is by replacing stone dust with sugarcane bagasse ash. Replacing of stone dust by sugar cane bagasse ash are in the following order of percentage i.e. 2%, 4%, 6%, 8% and 10%. On The other hand, modification of bitumen with molasses was also conducted. The modification was also done in following order of percentage i.e. 2%, 4% , 6%, 8%, 10% of bitumen was replace by molasses.. In addition, samples were made where both modification of bitumen with molasses and also at the same time sugar cane bagasse ash was added as filler in the mix was done. There will be a comparison between the modified mix and the normal mix.*

Keywords- sugarcane bagasse ash, molasses, modification.

I. INTRODUCTION

India is the second largest growing economy in the world therefore the road structure is emerging at a very fast rate. India is also a place with rapid increase in transportation sector with continuous increase in heavy traffic vehicles and other facilities that is using the road, improper maintenance leads to deterioration of the road pavement. Due to the growing of traffic and heavy loading of the vehicles the lifecycle of the road decline. The riding value also gets decrease, due to this road failure which results disturbance to the passengers, vehicle operating cost and proper maintenance of the roads. Climate change, rainfall intensities, characteristic of the soil and terrain condition are also some of the main reason for the failure of the pavement in India. To solve this problem related to the failure of pavement a considerable amount of research is require. It can be modifications of bitumen or by adding some waste products as fillers. For modification some are using crumb rubber, molasses and other recycled product. Some of the example of waste product are fly ash, rice husk ash, sugar cane fiber, stone dust, sugarcane bagasse ash and other waste products can be used as fillers.On the other hand further study is going on with the modification of bitumen with molasses and sugarcane bagasse ash as fillers in bituminous concrete. In India, Punjab and Uttar Pradesh are popular for cultivation of sugarcane.

Sugarcane fiber are the fibers that are obtained from sugarcane later the abstraction of the main extract from sugarcane. Mainly sugarcane fiber is called the “bagasse”, it is a waterlesssoft tissue residue left after the extraction of juice from sugarcane. This waste product can be used for many construction purposes, it can be used for replacement with other materials. By replacing with some other materials it can gain good results such as improving the strength and stability of the mix. The bagasse was collected and burnt. After burning the bagasse ash a layer of light colored ash was observed and then an ash of black color was obtained, consisting of left overs of sugarcane bagasse that was not burned as well as charcoal particles.

Figure (a). sugar cane bagasse ash

Molasses is the liquid product that was collected after the withdrawal of sugar from sugarcane. The properties of molasses can fluctuates by the quantity of sugar. According to the amount of sugar withdraw the color, sweetness may differ. During the process of sugar extraction, the extracted liquid is boiled, crystalizes and precipitate out. The extract left after crystallization is called as molasses. Generally the whole process is done in 3 stages i.e. boiling, crystallization and precipitation. With each stage the amount of sugar goes on decreasing.

Figure (b).Molasses

Functions of different materialsin the mix

Coarse Aggregate: For the mixture resolutions coarse aggregate from the size 20 mm and below are taken. Categorizing of aggregate can be done precisely as mentioned in MORTH. In bituminous paving mixes coarse aggregates can be established by the portion where the mixture of aggregates engaged in 2.36 mm sieves.

Fine aggregates are those aggregates which passes from 4.75 mm sieve and retained on 0.075mm.

Table1. Shows the grading of aggregate by MORTH terms.

Grading	1	2
Nominal aggregate size*	19 mm	13.2 mm
Layer thickness	50 mm	30-40 mm
IS Sieve (mm)	Cumulative % by weight	of total aggregate passing
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Min 5.2*	Min 5.4*

Bitumen is adhesive, dark and extremely sticky fluid or semi-solid form of petrol. It is mainly used in highway production where it is used as the paste or binder mixed with aggregate particles to create bituminous concrete. The term “Asphalt” and “bitumen” are often used interchangeably to mean both natural and manufactured forms of the substances. In this case we used penetration 60/70 for the mix.

Fillers are the tiniest materials that can be apply to the mixture. It stiffens and strengthen the binder. It improve the properties of the mixture.

II. LITERATURE REVIEW

Er. AmanJoon, Irfan Ahmad Najar et al (2014) concentrate on “Design of low volume traffic pavement using bagasse ash”. With a view to create a greener environment and to reduce pollution in the construction area, in this study paver

block can be created by adding bagasse ash and this paver block it can be used for village road, other district road etc. where there is less traffic volume. On the other hand as we all know that compressive strength is one of the most significant factors of pavement. In this study the results show that the characteristic of the soil and CBR value was obtained during the testing. For the sample with CBR rate of 6%, by using bagasse ash for the paver block the thickness of the pavement obtain was 566 mm which is much greater than the effective CBR rate of 7% which shows that the thickness of the pavement obtained was 488 mm, but in other way it was cheaper by 23.50%. The life span of the paver block using bagasse ash pavement was 20 years. For compressive strength testing, the rate of strength gaining was very slow for bagasse ash paver blocks.

A.A Murana and L.Sani (2015) focuses on "Partial replacement of cement with bagasse ash in hot mix asphalt". In this study, the wastes product (bagasse ash)was used to replace instead of cement in hot mix asphalt. Several waste product can be used for different purposes such as using as fillers, modification of bitumen and also for replacement. In this study, bitumen content of 4.5%, 5.5%, 6.5%, and 7.5 % was implemented. The main concentration contains the replacement of cement with bagasse ash partially in the succeeding direction,0%(control), 10%, 20%, 30%, 40% and 50%. The outcomes obtained shows that the replacement of cement with bagasse ash in the mixes has reveal acceptable results with a normal bitumen content of 5.5%. The results shows that the stability rises when the Bagasse Ash content falls. Flow value at 5.5% bitumen content was noted that it was constant at 2.5mm. The % Air void declining with the increase in bitumen content. All the values of VMA are within condition exclude 30% Bagasse Ash replacement and it gives that the VMA values of 5.5% bitumen content was 16%. At 10% Bagasse Ash replacement, it come under the specification in Asphalt institute for strength. The optimum bitumen content to be replaced with cement was 10%.

David D.M. Huwae, L.R. Parera et al (2016) focuses on "Bagasse Ash as filler in Hot Rolled Sheet Mixture". Here, this research meant to examine the usage and impact of bagasse ash as a filler in HRS (Hot Rolled Sheet) mixture. Bagasse ash can also be used as fine aggregate. Here 20%, 40%,60%, 80% and 100% are the following order of percentage to add bagasse ash filler in HRS. The outcomes shows that 60% of Bagasse ash obtained the stability value of 1205.04 kg with flow value of 4.427 mm, VMA is 20.249%, VFA 74.206%. Though the Marshall parameters are lower but it has fulfilled all the standard requirements of HRS mixture. The use of BA as a filler can both compact the desires of cement filler and deliver equally extra ordinary profitable value in addition to overpowering the present waste.

M.ZulfrikriM.Zainudin, F.HanimKhairuddin et al (2016) concentrate on "Effect of Sugarcane Bagasse ash as filler in Hot Mix Asphalt''. The study was directed to evaluate the effect of sugar cane bagasse ash (SCBA) as used as filler in HMA. Investigational were done to match the properties of standard HMA sample with improved HMA sample using SCBA as filler. Both the sample result were then match to the Malaysian publics works department specifications. Here in this study the percentage of bagasse taken are 0.1%, 0.2%, 0.3%, 0.4% and 0.5%. Results show that the concentrations among both trials were likely identical, for VTM outcomes sugarcane bagasse ash contributes greater rate with transformation of 0.83% from HMA tester. This illustrate that by addition sugarcane bagasse ash as filler in the mix, air voids in the sample were increased. On the other hand, sugarcane bagasse ash sample increases Marshall Stability by 0.6 % and flow by 4.9% respectively when compares with the HMA sample. Which reveal the results that modified sample has higher value than normal sample.

Santharam et al(2017) focuses on "Construction products with sugarcane ash binder". This study is dedicated on the presentation of sugar cane bagasse ash as a component in construction ingredients such as alkali-activated concrete, paver blocks and unburnt bricks. Effects from the study exposed important expansion in the characteristics, precisely strength and toughness of bagasse ash blended specimens. Sugarcane bagasse ash and slag based ambient preserved geo polymer sample exhibited development in compressive strength and workability in assessment with slag based geo polymer. Water engagement in SCBA unburnt bricks was higher compared to fly ash bricks.

Shetty Ashish Vishwanath, R. MahadevaSwamy (2017) concentrate on "Experimental Investigation of Sugarcane Bagasse Ash and Glass Powder as partial replacement of cement in concrete". This project objectives to recognize the prospective of sugarcane bagasse ash and its practice in cementitious classification. This study contracts with the consequence of usage of an established sugarcane bagasse ash and burned and powdered bagasse ash as additional resources on belongings of cement and cement mortar. This study effort to create practice of bagasse ash as a pozzolani celements to interchange cement. Chemical and physical configuration are obtained. Investigation was agreed to inspect the influence of substituting cement by bagasse ash and glass powder to find out the mechanical and physical properties of pastes and mortars, new and reinforceconcrete such as uniformity,

setperiod and workability of the compressive strength. It is establish that the strong pointrises with adding of bagasse ash.

Shakti Kumar, Dr. A.K. Mishra (2016)focuses on the "Investigation of fly ash as a filler in bituminous mix- an overview". For assessmentdedications, fillers normally used, like cement (OPC) and fly ash had been reflected as control samplings and replaced specimens. In this investigation, 5% bitumen content was taken as ideal for bituminous concrete mixes.Marshall Stability properties of 25%, 50%, 75% and 100% of fly ash content are within desirable limits for 5% optimum bitumen content. 75% of fly ash content gives best results. The standardsconsiderations i.e. Vv, VMA and VFB in those cases fly ash was establish out to be within required specifications. This study not only beneficiallyconsumes the left-over fly ash in highwayproduction industry but also successfully improved the important properties that will finally have greater and long lasting roads. This study give a constructiveimpression on the environment, it will also lessen the amount of unused products by burning and land-dwelling. This will also create a technology which will be ecological but also not only count value to the waste products.

Jijo James and PitchaiKasinathaPandian (2016) concentrates on the "Valorisation of sugarcane Bagasse Ash in the manufacture of Lime stabilized block". The studies examine the possibilities of lime in making of steadied soil blocks and the valorisation of a compacted left overs, Bagasse ash in its production. Existing dirt was composed from a close by area and categorized in the soil test center as a clay of transitional flexibility. The quantity of the stabilized soil which was using the lime was governed from the Eades and Grim pH test. During the mixing processthe lime stabilized soil was modified with numerous Bagasse Ash content and precast into blocks of 9 cm x 9 cm x 19 cm. Curing of these block take place over a period of 28 days and following with different test like test for compressive strength, water absorption and efflorescence tests. The outcomes of these different test shows that with the addition of Bagasse ash it improve the compressive strength, rise in the water absorption, the results shows no efflorescence. This ongoing study shows that bagasse ash can be successfully valorized in producing stabilized soil blocks.

K.shyam Prakash, M. panindra, et al (2014)focuses on the "percentage replacement of bitumen with molasses". For modification of bitumen molasses can be used, molasses can be available in the nearby areas where there is sugarcane industries, this investigation not only utilizing the molasses just for experimenting purpose but to applied it to the real world, this wastes product improved the roads safety, strength, visibility etc. From the study it shows that the behavior of molasses modified bituminous mix came out that the modified mix has some improvements. It was obtained that the stability values raises up to 13% and lower down. When molasses was added to the sample it was obtained that the flow value also decreases. The parameters such as Vv, Vb, VMA, and VFB are within the required specifications. By addition of molasses to the bituminous mix, the releasing of carbon dioxide decreases as well as the products of molasses is decreases which are very harmful to human health. By spraying this molasses over the aggregates increases binding characteristics. The molasses modified bituminous mix reduces the air void present in the mix; this avoids the moisture absorption. It can be eco-friendly too.

G.Rameshkumar, S.Bharani et al (2017), focuses on the "Partial replacement of bitumen by waste plastic and polypropylene in road construction". Dumping of unusedplastic has becoming a very problematic situation all over the world.Now a days, throwing away of unused plastic has become matter of great apprehension for environmental engineers due its non-recyclablefeatures and health risk. In this study these waste product can be used for different purposes like modifiers, replacement etc. Some of the modifiers are quite expensive and usually not available in all the places, instead these waste product like plastic and polypropylene can be used as modifier of bitumen. In this case, 1%, 3%, 5% and 7% was taken as the percentage of modifier to be added by weight of bitumen in the creation of bituminous mixture. The results reveal that when mixing the plastic waste along with bitumen it rises the water resistivity, its volume and also its constancy. The flow and stability of the mix is increases with the combining the waste plastic.On the beginning of trial work it is decided that the mixtures with unused plastic and polypropylene modifier can be practice for the manufacture of flexible pavement especially in a warmer region due to its stability ad flow appearances.

GemechuYilikaMose and PalaniPonnurangam (2018) mention that they had been performing on the investigation of the effect of cane molasses on the performance of base bitumen. This research is done to find out the effect of bitumen by adding three different stage of molasses A, B and C. The bitumen was mix along with the molasses at different order of percentage from 0%, 5%, 10%, 15%, and 20%. Different test was conducted which include PG Test, RTFO test and all the basics test of bitumen. As per the test results it reveals that the performance grade of the bitumen (40/50) shows that by adding 20% of molasses A, 10% of molasses B and 5% of molasses C it expands the act of the original bitumen by 28.12%, 15.79% and 8.17% correspondingly. The penetration grade reduces by 36.87% for 15% of molasses A

mixtures, 28.38% for 10% of molasses B mixtures and 12.76% for 5% of molasses C mixtures. Likewise, the ductility reduces by 21.36% for 15% molasses A mixtures, 6.79% for 10% molasses B mixtures and 5.82% for molasses C mixtures. According to the RTFO test results the performance grade for molasses A remains the same after aging but reduces by one grade for molasses B and molasses C as compared with the performance before aging. When compared the results with the standard specifications, the performance grade of original bitumen was improved using addition of different percentage of molasses with different rate. Whereas the penetration and ductility test value demonstrate that when the percentage of the mixture increases the value of penetration and ductility decreases as compared to ASTM condition. According to ASTM specification, if the softening point value increases as the percentage of the mixture increase it indicates that the densities and the stiffness of the mixture improve which in this case it was positive. Overall in this investigation it displays that the outcome was positive.

M.Prudhvi, Dr.M.Kameswar Rao (2017) studied the stabilization of gravel soil by using molasses-lime. This study was conducted to find out the effect of the soil characteristics by adding molasses and lime to the soil. Different test was conducted to the soil which include plastic index, direct shear test and compaction. Here, molasses and lime contaminated soil samples are made in different order of percentage i.e. 5%, 10%, 15%, 20% and 25%. At 10% of molasses and lime soil samples when increase the friction angle of the soil from 9◦ to 19◦ it displays that the cohesion of soil was increasing from 0.25 to 0.6. The maximum dry density of the soil also rises at 10% of molasses-lime soil samples which is 1.933gm/cm^3. With the increase in molasses and lime percentage the optimum moisture content also rises from 10% to 12%. It also shows that by adding 10% of molasses-lime to the soil sample the co-efficient of permeability decreases from 4.566E-05 to 2.06E-05. The overall results shows that by adding molasses-lime to the soil it improve the properties of the soil but when the addition of molasses-lime to the soil exceeds 10% it demonstrate that there is a decrease in the strength. Addition of molasses-limes to the soil helps to attain optimum strength.

Findings from the literature review

Er. AmanJoon, Irfan Ahmad Najar et al (2014) studied to design of low volume traffic pavement using bagasse ash. For cheaper road construction and greener environment they introduce sugarcane bagasse ash as an extra materials to add in manufacturing paver blocks, but it has been difficult as the results does not reach within the condition and shows that the rate of strength is slower when bagasse ash is added. But this is a cheaper way to manufacture paver blocks by adding unused product of sugarcane and it can be used as footpath, village roads etc. which has less traffic volume.

A.A Murana and L.Sani (2015) studied to partially replace cement with bagasse ash in hot mix asphalt. Here, swapping of cement with bagasse ash partially in the succeeding direction, 0% (control), 10%, 20%, 30%, 40% and 50%. And with these percentage of bagasse ash to be replace with cement shows that the stability increases when the bagasse ash content decreases. And flow value at 5.5% bitumen content was 2.5 mm and it was constant. % air void was decreases when the bitumen content increases, all the values are within specifications and the optimum bitumen content to be replaced with cement was 10%.

David D.M. Huwae, L.R. Parera et al (2016) studiedto use bagasse ash as fillers in hot rolled sheet mixtures. . Here 20%, 40%, 60%, 80% and 100% are the following order of percentage to add bagasse ash filler in HRS. The outcomes shows that 60% of Bagasse ash obtained the stability value of 1205.04 kg with flow value of 4.427 mm, VMA is 20.249%, VFA 74.206%. Though the Marshall parameters are lower but it has fulfilled all the standard requirements of HRS mixture.

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S.Deepika, G.Anand, et al (2017) studied theConstruction products with sugarcane ash binder, Effects from the study exposed important expansion in the characteristics, precisely strength and toughness of bagasse ash blended specimens. Sugarcane bagasse ash and slag based ambient preserved geopolymer sample exhibited development in compressive strength and workability in assessment with slag based geopolymer.

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to inspect the influence of substituting cement by bagasse ash and glass powder to examine for the mechanical and physical properties of pastes and mortars, new and harden concrete such as constancy, setting period and workability of the compressive strength. It displays that the strength rises while adding sugarcane bagasse ash.

Shakti Kumar, Dr. A.K. Mishra (2016) studied to find out the effect of fly ash as filler in bituminous mix, in this study 5% bitumen content was taken as ideal for bituminous concrete mixes.Stability Properties of 25%, 50%, 75% and 100% of fly ash content are within desirable limits for 5% optimum bitumen content. 75% of fly ash content gives best results. So, here fly ash content at 75% was taken as the optimum fly ash content. All the values are within the specifications.

Jijo James and PitchaiKasinathaPandian (2016) studied to find out the valorisation of sugarcane Bagasse Ash in the manufacture of Lime stabilized block. Here, During the mixing processthe lime stabilized soil was modified with numerous Bagasse Ash content and precast into blocks of 9 cm x 9 cm x 19 cm. Curing of these block take place over a period of 28 days and following with different test like test for compressive strength, water absorption and efflorescence tests. The outcomes of these different test shows that with the addition of Bagasse ash it improve the compressive strength, rise in the water absorption, the results shows no efflorescence. This ongoing study shows that bagasse ash can be successfully valorized in producing stabilized soil blocks.

K.shyam Prakash, M. panindra, Ram surya and J. Naresh. (2014) studied the percentage replacement of bitumen with molasses, from the study it shows that the behavior of molasses modified bituminous mix came out that the modified mix has some improvements. It was obtained that the stability values raises up to 13% and lower down. When molasses was added to the sample it was obtained that the flow value also decreases. The parameters such as Vv, Vb, VMA, and VFB are within the required specifications. By addition of molasses to the bituminous mix, the releasing of carbon dioxide decreases as well as the products of molasses is decreases which are very harmful to human health. By spraying this molasses over the aggregates increases binding characteristics. The molasses modified bituminous mix reduces the air void present in the mix; this avoids the moisture absorption.

G.Rameshkumar, S.Bharani et al (2017) did the experiment to partially replace bitumen by waste plastic and polypropylene in road construction, In this case, 1%, 3%, 5% and 7% was taken as the percentage of modifier to be added by weight of bitumen in the creation of bituminous mixture. The results reveal that when mixing the plastic waste along with bitumen it rises the water resistivity, its volume and also its constancy. The flow and stability of the mix is increases with the combining the waste plastic**GemechuYilikaMose and PalaniPonnurangam** (2018). Mention that by utilizing three grade of molasses i.e. A, B and C to find out the outcomes on the performance of base bitumen. The test results reveals that the overall outcomes shows positive results.

M.Prudhvi, Dr.M.Kameswar Rao (2017)
This study was conducted to find out the effect of the soil characteristics by adding molasses and lime to the soil. The outcomes shows that by adding molasses with lime in the soil it improve the properties and characteristics of the soil.

III. CONCLUSION

It is observed that there are some research which used bagasse ash gives a very successful outcomes and a few research gives fair results. The main objective of these experiment was to find out whether the waste product such as plastic, sugarcane bagasse ash, etc. can be utilized for different purposes in manufacturing road construction.i.e. by adding these waste product as fillers in the mixture and also by replacement with other materials in the mix . Hence it can be assure that these product can be very useful for the future used and also reduces the cost of construction.

REFERENCES

[1] A.A Murana and L. Sani (2015) "Partial Replacement of Cement with Bagasse Ash in Hot Mix Asphalt". Volume: 34, No.4, October 2015 pp.699-704.
[2] David D.M. Huwae, L.R.et al (2016) "Bagasse Ash as Filler in Hot Rolled Sheet (HRS) Mixture". The 2016 World Congress on Advances in Civil, Environmental and Materials Research (ACEM16) Jeju Island, Korea, August 28- September 1, 2016.
[3] Er. AmanJoon, Irfan Ahmad Najar et al (2014) "Design of low volume traffic pavement using bagasse ash".Volume:04 Issue:04, April 2017
[4] G.Rameshkumar, S.Bharani et al "Partial Replacement of Bitumen by Waste Plastic and Polypropylene in Road Construction". Volume 4, Issue 11, 2017
[5] Gemechuyelikamose and PalaniPonnurangam "Investigation the effect of cane molasses on the performance of base bitumen". Volume III, Issue VI, June 2018.
[6] Jijo James and PitchaiKasinathaPandian (2016) "Valorisation of sugarcane Bagasse Ash in the manufacture of Lime stabilized block". Volume 24, 2016, No. 2, pp.7 – 15

[7] K.shyam Prakash, et al (2014) "percentage replacement of bitumen with molasses". Volume 5, Issue 7, July (2014), pp.188-197.
[8] M.Zulfikri, F.HanimKhairuddin, et al (2015) "Effect of Sugarcane Bagasse Ash as a filler in Hot Mix Asphalt". Vol.846, pp.683-689.
[9] Ministry of Roads Transport and Highways (MORTH), specification for road and bridge works, 5th edition, Indian Roads Congress New Delhi 2013.
[10] M.Prudhvi, Dr. M.KameswarRoa "Stabilization of gravel soil by using molasses-lime". Volume 02- Issue 06/ June 2017 \\PP-01-06.
[11] S.Deepika, et al (2017) "Construction Products with Sugarcane Bagasse Ash binder". Volume : 05 Issue 03/ march 2018
[12] Shetty Ashish Vishwanath , R. MahadevaSwamy (2017) "Experimental Investigation of Sugar cane Bagasse Ash and Glass Powder as partial replacement of cement In concrete". Volume 4, Issue 5, May 2017.
[13] Shakti Kumar, Dr. A.K. Mishra (2016) "Investigation of impact of Fly ah Ash as a filler in bituminous mix- an overview". Volume 4, Issue 03, 2016