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Use of Reclaimed Asphalt Pavement and Bagasse Ash in Bituminous Flexible Pavement

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***Abstract:** An attempt has been made to utilize the waste material such as reclaimed asphalt pavement and bagasse ash by replacing coarse aggregate sieve by sieve and cement while preparing the bituminous mix sample. The usage of RAP was done at different proportions of 15%, 30% and 45% by the weight of coarse aggregate and bagasse ash was used at different proportions of 5%, 7.5% and 10%. Various tests on bitumen, aggregates and obtained bituminous samples were conducted for final results. Therefore, from the results obtained, it can be concluded that all the results of replacement mixes were found to be within the limits of MORTH 5th revision requirement and they have shown the satisfactory results also. The usage of RAP and Bagasse ash can be done effectively*

***Keywords :** Reclaimed Asphalt Pavement, Bagasse Ash, Marshall Stability Test.*

I. INTRODUCTION

Flexible pavement is made up of bituminous binding material surface course along with underlying base and sub-base course. This bituminous substance is generally called asphalt whose viscous nature permits permissible plastic deformation of the material. Normally, asphalt surface is constructed on base of gravel, but sometimes asphalt surface is constructed directly on the subgrade course. The categorization of the asphalt is dependent on the applying temperature, such as hot mix asphalt (HMA), warm mix asphalt, cold mix asphalt etcetera.

The strength of flexible pavement depends on the strength of subgrade soil strata as if the subgrade soil deforms due to any reason then the deformation of the flexible pavement takes place. This occurred because of the load distributing characteristics of different layered system. The transference of the load is done locally to the subgrade through a combination of different layers. But dispersion of the load is limited to smaller area of the subgrade layer. The main advantage of flexible pavement is that it entails low initial construction cost which is the main reason that this type of pavement is used commonly worldwide.

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However, the maintenance cost of the flexible pavement is huge as it requires regular repair works. Moreover, the flexible pavement tends to deteriorate easily with abrasion which results in cracks and potholes. This problem creates havoc to the traffic on roads.

Asphalt pavement is generally constructed of stone-aggregate, sand, additives and liquid (petroleum) asphalt. Liquid asphalt, is sticky black material which is used for binding purposes in this kind of pavements. This material is viscous in nature but it is found in semi solid state. Normally, asphalt is also called bitumen as they both are the same material. This type of pavement entails 90-95% of stone aggregate and sand and 5-10% of liquid asphalt which are mixed together after warming these raw ingredients. Liquid asphalt has high viscosity which binds the aggregates together. Flexibility of the same is retained once the material tends to cool down but it gets harder and more stiff if the asphalt surface becomes more cool. Therefore, cooler the asphalt surface, lesser will be the flexibility of pavement. the flexibility of asphalt pavement is one of the major merits which allows the pavement to adapt the changes in its properties due to weather conditions or any other conditions.

Sugarcane bagasse ash is the end product of sugar industries which is collected after burning sugarcane bagasse once the extraction of sugarcane juice is done. Lots of problems were faced previously related to its disposal as it causes environmental impacts. The utilization of sugarcane bagasse ash in the construction industries is becoming popular. Many research work in the past has been done on concrete while replacing cement with bagasse ash. Therefore, there is a huge need to understand the physical properties of bagasse ash and concrete containing bagasse ash and the advantages over conventional concrete.

I. OBJECTIVES

The main objectives of this study are listed below:

Use of Reclaimed Asphalt Pavement RAP with different proportions in bituminous mix.

To replace the cement content with the bagasse ash with variable proportions in bituminous mix.

To perform Marshall Stability test on obtained bituminous mixes.

To find the optimal percentage of Reclaimed Asphalt pavement RAP for bituminous concrete.

II. TESTING METHODOLOGY

Following are the laboratory test which was carried out for the present research work:

1. Test carried out in order to determine the characteristics of binder:
   a. Ductility test
   b. Softening test
   c. Penetration test
2. Gradation of Reclaimed asphalt pavement aggregate was done.
3. Marshal stability test was carried out after preparing bituminous mix samples with different proportions of RAP and bagasse ash. Stability value and flow value was obtained from this test.
4. Change of binder content was done, if required.

III. RESULTS

An attempt has been made to utilize the waste material such as reclaimed asphalt pavement and bagasse ash by replacing coarse aggregate sieve by sieve and cement while preparing the bituminous mix sample. The usage of RAP was done at different proportions of 15%, 30% and 45% by the weight of coarse aggregate and bagasse ash was used at different proportions of 5%, 7.5% and 10%.

Table 1: Various Bituminous Mix.

Bituminous Mix	RAP %	BA %
Raw Bituminous Mix	-	-
Bituminous Mix 1	15	5
Bituminous Mix 2	30	7.5
Bituminous Mix 3	45	10

Table 2: Quantity of Aggregates Used.

Sieve Size	Weight (g)
26.5 mm	0
19 mm	78
13.2 mm	333.6
9.5 mm	88.8
4.75 mm	136.8
2.36 mm	177.6
1.18 mm	82.8
0.6 mm	96
0.3 mm	57.6
0.15 mm	57.6
0.075 mm	34.8
Pan	56.4

Table 3: Results of Marshall Stability Test for Raw Bituminous Mix.

% Volume of Voids Vv	4.02	3.94	4.01	3.88	4.21
% Volume of bitumen Vb	7.515	8.792	10.064	11.376	12.5825
Volume of mineral Aggregate VMA	11.54	12.73	14.07	15.25	16.79
% Volume Filled with bitumen VFB	65.13	69.06	71.53	74.58	74.95
Marshall Stability (KN)	12.89	13.06	13.54	12.95	12.29
Flow Value	3	3.1	3.3	3.2	3.7
Marshall Quotient	4.30	4.21	4.10	4.05	3.32
Density g/cc	4.02	3.94	4.01	3.88	4.21

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Table 4: Results of Marshall Stability Test for Bituminous Mix 1.

% Volume of Voids Vv	3.74	4.08	4.22	4.41	4.34
% Volume of bitumen Vb	7.494	8.7325	9.996	11.214	12.445
Volume of mineral Aggregate VMA	11.23	12.81	14.21	15.63	16.79
% Volume Filled with bitumen VFB	66.72	68.18	70.33	71.77	74.13
Marshall Stability (KN)	10.35	11.05	11.84	11.31	11
Flow Value	2.8	2.9	3.1	3.4	3.3
Marshall Quotient	3.70	3.81	3.82	3.33	3.33

Table 5: Results of Marshall Stability Test for Bituminous Mix 2.

% Volume of Voids Vv	3.85	3.84	4.02	4.18	4.21
% Volume of bitumen Vb	7.569	8.848	10.124	11.358	12.62
Volume of mineral Aggregate VMA	11.42	12.69	14.14	15.53	16.83
% Volume Filled with bitumen VFB	66.29	69.73	71.58	73.12	74.97
Marshall Stability (KN)	11.05	11.59	12.51	12.21	11.43
Flow Value	2.9	3.1	3.5	3.9	3.6
Marshall Quotient	3.81	3.74	3.57	3.13	3.18

Table 6: Results of Marshall Stability Test for Bituminous Mix 3.

% Volume of Voids Vv	3.61	3.52	3.79	3.80	4.14
% Volume of bitumen Vb	7.455	8.7185	9.952	11.1645	12.39
Volume of mineral Aggregate VMA	11.06	12.24	13.74	14.96	16.53
% Volume Filled with bitumen VFB	67.39	71.21	72.42	74.61	74.96
Marshall Stability (KN)	9.84	10.24	10.67	9.98	9.91
Flow Value	3	3.2	3.4	3.3	3.5
Marshall Quotient	3.28	3.20	3.14	3.02	2.83

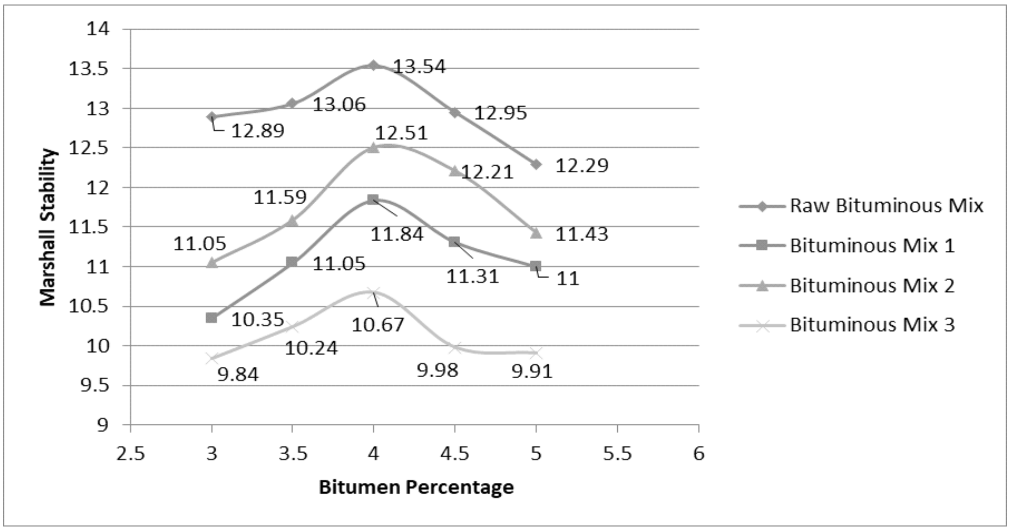

Figure 1. Graph Between Bitumen Percentage and Marshall Stability.

Therefore, the maximum Marshall Stability value of Raw bituminous mix was 1354 kg at 4% optimum bitumen content. It was observed that the maximum value of Marshall Stability after replacement was attained for Bituminous Mix 2 i.e. 1251 kg at 4% optimum bitumen content. Therefore, it was concluded that 4% is the optimum binder content for the present study.

All the values of Marshall Stability were above the minimum required range of 900 kg (9Kn) as per the specifications of MORTH, 5th revision published by IRC.

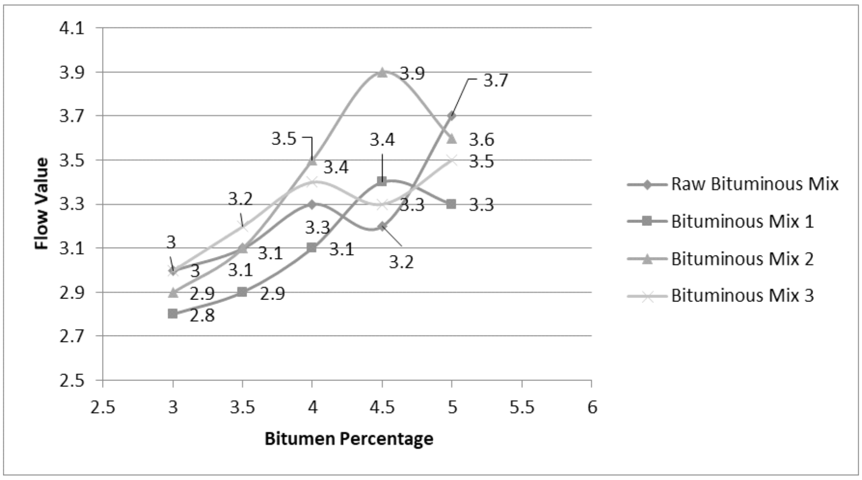

Figure 2. Graph Between Bitumen Percentage and Flow Value.

From the figure above, it was observed that there was a slight variation in the flow values obtained for various bituminous mixes. All the flow values of raw bituminous mix and replacement bituminous mix lie within the range of 2mm to 4 mm given by the MORTH, 5th revision published by IRC.

IV. CONCLUSIONS

After scrutinizing the obtained results, the various conclusions were made and represented in the following section.

By considering the specification of bituminous mix given in the table 500-11 of MORTH 5th revision, binder content 4% was found out to be the most optimum binder content for raw bituminous mix. Whereas, the optimum binder content for replacement mixes was found out to be 4%. Therefore, it can be concluded that 4% is the optimum content of bitumen.

At the optimum binder content, the density of the mix was 2.621 g/cc for the raw mix which is slightly higher than the bituminous mix 1 i.e. 2.609 g/cc. The maximum density was attained by bituminous mix 2 (i.e. 2.637 g/cc) which is slightly greater than raw mix.

The Marshall Stability value was also found to be in the limits as per MORTH 5th revision. The Marshall Stability value at optimum binder content of raw mix was found out to be 1354 kg. Whereas, the Marshall Stability value of bituminous mix 1, mix 2 and mix 3 at optimum binder content was 1184 kg, 1251 kg and 1067 kg respectively.

Flow values of all the mixes were also found under the limits of MORTH 5th revision i.e 2mm – 4mm. The flow value at optimum binder content of raw mix was found out to be 3.3 mm. Whereas, the flow values of bituminous mix 1, mix 2 and mix 3 at optimum binder content was 3.1 mm, 3.5 mm and 3.4 mm respectively.

The percentage of VMA of all the replacement mixes was higher than value of the raw mix except for the bituminous mix 3. The VMA value of raw mix, bituminous mix 1, mix 2 and mix 3 at optimum binder content was found out to be 14.07%, 14.21%, 14.14% and 13.74% respectively.

VFB value of raw mix, bituminous mix 1, mix 2 and mix 3 at optimum binder content was found out to be 71.53%, 70.33%, 71.58% and 72.42% respectively.

Therefore, all the results of replacement mixes were found to be within the limits of MORTH 5th revision requirement and it has shown the satisfactory results also. Therefore, all the proportions of RAP and BA can be considered as optimized proportions and the usage of RAP and Bagasse ash can be done effectively on the basis of requirements and availability.

REFERENCE

1. N K S Pundhir, C Kamaraj and P K Nanda (2005). "Use of copper slag as construction material in bituminous pavements", Journal of Scientific & Industrial Research., Vol. 64, pp. 997-1002.
2. Mehmet Yilmaz & Baha Vural Kok (2008). "Effects of ferrochromium slag with neat and polymer modified binders in hot bituminous mix", Indian Journal of Engineering & Materials Sciences, Vol. 16, pp. 310-318.
3. Sabina1, Tabrez A Khan et.al (2009). "Performance evaluation of waste plastic/polymer modified bituminous concrete mixes" Journal of Scientific & Industrial Research, vol 68, pp 975-979.
4. Akshaya Kumar Sabat (2012). "Utilization of Bagasse Ash and Lime Sludge for Construction of Flexible Pavements in Expansive Soil Areas, in Electronic Journal of Geotechnical Engineering, pp. 1037–1046.
5. Anand J. Puppala, Sireesh Saride, Richard Williammee (2012). "Sustainable Reuse of Limestone Quarry Fines and RAP in Pavement Base/Subbase Layers", Sustainable Reuse of Limestone Quarry Fines and RAP in Pavement Base/Subbase Layers, pp. 418–429.
6. T.Anil Pradyumna, Abhishek Mittal, Dr.P.K.Jain (2013). "Characterization of Reclaimed Asphalt Pavement (RAP) for Use in Bituminous Road Construction", Elsevier, pp. 1149 – 1157.
7. Jashanjot Singh, A.K Duggal (2015). "An Experimental Study on Reclaimed Asphalt Pavement In Bituminous Concrete", IJMTER, pp. 445–453.
8. A. A. Murana, and L. Sani2 (2015). "Partial Replacement Of Cement With Bagasse Ash In Hot Mix Asphalt", Nigerian Journal of Technology (NIJOTECH), Vol. 34, No.-4, pp. 699 – 704.
9. Jaspreet Singh, Jashanjot Singh, A.K Duggal (2015). "A Review Paper On Reclaimed Asphalt Pavement (Rap)", IJMTER, pp. 454–456.
10. Ali Behnood, Mahsa Modiri Gharehveran et.al (2017). "Effects of copper slag and recycled concrete aggregate on the properties of CIR mixes with bitumen emulsion, rice husk ash, Portland cement and fly ash", ELSEVIER, Page No. 172-180.
11. Thomas W. Kennedy, Weng O. Tam, and Mansour Solaimanian-"Effect of reclaimed asphalt pavement on binder properties using the SUPERPAVE system" Report No FHWA/TX-98/1250-1, September 1998, Centre for transportation research, bureau of engineering research, university of Texas at Austin.

12. Ramzi Taha, Ali Al-Harthy,Khalid Al-Shamsi,and Muamer Al-Zubeidi-"Cement Stabilization of Reclaimed Asphalt Pavement Aggregate for Road Bases and Subbases" Vol. 14, No. 3, May/June 2002,Journal of Materials in Civil Engineering, , pp. 239-245
13. Baoshan Huang,Guoqiang Li,Dragan Vukosavljevic,Xiang Shu and Brian K. Egan-" Laboratory Investigation of Mixing Hot-Mix Asphalt with Reclaimed Asphalt Pavement" Journal of the Transportation Research Board,No, Transportation Research Board of the National Academies, Washington,D.C., 2005, pp. 37–45.
14. Feipeng Xiao,Serji Amirkhanian,M.ASCE,and C. Hsein Juang-"Rutting Resistance of Rubberized Asphalt Concrete Pavements Containing Reclaimed Asphalt Pavement Mixtures" Vol. 19, No. 6, June 2007,Journal of Materials in Civil Engineering, , pp. 475-483
15. Valdés Gonzalo, Pérez-Jiménez Félix, Miró Rodrigo-"Experimental Study Of Recycled Asphalt Mixtures With High Percentages Of Reclaimed Asphalt Pavement (RAP)" November 13,2009,Annual Meeting of the Transportation,
16. Amir Tabaković,Amanda Gibney,Ciaran McNally, and Michael D. Gilchrist- "Influence of Recycled Asphalt Pavement on Fatigue Performance of Asphalt Concrete Base Courses" Vol. 22, No. 6, June 1, 2010 Journal of Materials in Civil Engineering,
17. Jaafar Abubakar Sadeeq, Jibrin Mohammed Kaura, Ochepo Joshua and Ahmad Rabilu-"Recycling of Reclaimed Asphalt Pavement (RAP) with Rice Husk Ash (RHA)/Ordinary Portland Cement (OPC) Blend As Filler" Volume 8, No.4, 2014,Jordan Journal of Civil Engineering,
18. Randy C.West, J. Richard Willis-"Case Studies On Successful Utilization Of Reclaimed Asphalt Pavement And Recycled Asphalt Shingles In Asphalt Pavements" NCAT Report 14- 06,Auburn University,2014
19. J. Don Brock, Ph.D. and Jeff L. Richmond- "Milling And Recycling", https://www.roadtec.com, t127_techpaper_millingrecycling.pdf
20. SPECIFICATIONS FOR ROAD AND BRIDGE WORKS", MORTH (fifth revision), published by Indian Roads Congress
21. ASTM D 6927, "Test Method for Marshall Stability and Flow of Bituminous Mixtures", American Society for testing and materials
22. Indian Standard, "Paving Bitumen Specification (4th Revision)", IS 73:2013, Bureau of Indian Standard, New Delhi 13. Indian Standard, "Method for Test for aggregates for Concrete", IS 2386 (Part I & Part II), Bureau of Indian Standard, New Delhi.

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