International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 08, August-2019

"A STUDY TO USE OF WASTE MATERIAL IN BITUMINOUS CONCRETE (BC)"

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***ABSTRACT* : Development of any country is not possible without Connectivity of roads. Roads are the easy mode of transport to goods and passengers from one place to each place. Roads make a fundamental contribution to economic development and social benefits. It is more elastic other than transport. The main purpose of design the bituminous mix is to get the result in many terms like Durability and Resistitivity to deterioration. The safety of nature (environmental) is a Largest issue with the developing road networks. A mix designer always tries to achieve the optimum value of results through a number of tests and various proportions of available materials. The optimum bitumen content of mix plans can get by the asphalt (bitumen) content and different sizes of aggregates. The use of waste material fly ash and brick dust (conventional fillers) in Bituminous mixes not only displayed maximum marshall stability, but also decrease unit weight with increasing the fixed percentage of asphalt. The various types of Fillers (cement, brick dust, fly ash, stone dust and lime) can use in the design of bituminous mix which are the waste material of different industries. The use of waste materials as a filler for reducing the material cost and also for environmental benefits. Fly ash also can be used as mineral filler in the paving applications because it has low cost than other mineral fillers. Fillers improves the rutting resistance and the durability of the mix. .**

This testing has been done for the check the effect of fillers such as brick dust and fly ash in the mixes of asphalt pavement. The paper study gives the satisfying Marshall Properties result from the test with bituminous mixes prepare with brick dust and fly ash though requiring a bit high bitumen content. The fillers used in this study are to find out the solution of disposal which causes environment pollution.

Keywords—Bituminous mix, Filler, Fly ash, Lime, Brick dust

I. INTRODUCTION

The traffic volume depends on the population of a country. Construction of Highways in large number is very necessary for reducing the traffic load because they carry 40% of the traffic. The safety and cost-effective construction of the highway is a big task for transportation agencies. High-quality quality materials are required for maintenance of pavement and also in the construction of the road. The pavement transfer to traffic load to the lowest layer (foundation). The classification of pavement based on the load-bearing capacity, Modulus of elasticity and use of materials. Flexible pavement has a less modulus of elasticity than rigid pavement. Fatigue and thermal cracking both are a major failure on the flexible road. Life is shorter of Flexible pavement than rigid pavement. The physical failures may be found on the pavement and the sub-base. These structural failures occur due to overloading, and the frosting effect of the design. Different fillers (waste material) can be used in asphalt mixes to fill voids and improve the cohesion of binder. The high volume of fly ash is produced from thermal plants per year in India. Use of fly ash has been increased in concrete research (up to 40%).

Uses of fly ash and brick dust in bituminous binders give the longest life of the pavement. Determination the reasons for failure in the pavement is very essential to correction in mix design and solution of failure helps in construction for future projects. In this study, we examined the marshall value with fly ash and brick dust in bitumen mixes.

2.REVIEW OF LITERATURE

Ishai*et et. al*. (1980) had investigated six types of fillers possessing a wide range of properties, and two types of mixtures; sand asphalt and bituminous concrete (BC). They performed Rheological tests on filler-bitumen mastic samples, and mechanical tests on different Asphaltic mix samples. A basic model was adopted in which the bituminous mixture is composed of two components: an aggregate-bitumen system and a filler bitumen system (mastic). The model was analyzed through weight-volume relationship and the optimum bitumen needed to obtain the optimal mechanical actions of the mixture was determined**.**

Craus*et et. al*. (1981) investigated the role of fillers (Lime and Stone dust/Quarry Dust) in long term durability of bituminous concrete mixes. Durability tests were conducted on mixes consisting of one type of aggregate, one gradation and six types of filler. Durability potential was assessed by testing the mixture during and after 14 days of immersion in a 60oC water bath. The results indicated that the properties of fillers (Lime and Stone dust/Quarry Dust) have a pronounced effect on the durability of the mixture.

Chari and Jacob (1984) studied the influence of lime and stone dust fillers on the fatigue performance of bituminous concrete mixes. Among the two fillers; lime and stone dust were found to have substantial influence on the fatigue properties.

Imtiaz Ahmed and C. W. Lovell the value of paving materials (fly ash, blast furnace slag, steel slag, bottom ash, rubber tire and boiler slag) based on technical, economic and environmental factors has indicated that reclaimed have significant potential to replace conventional material for various used in construction of highway.

Suhaibani*et al*. (1992) reported the effect of filler type and content on the rutting action of bituminous concrete.

Kandhal (1993) discussed laboratory and field evaluation of several waste materials used in bituminous mixes. A general overview of these waste materials, including the research work done in the past and their potential for use in bituminous pavements was included in this study. Author suggested that recycling of waste materials in highway construction should be encouraged and demonstration projects should be undertaken to evaluate the performance of bituminous pavements containing waste materials.

Fwa and Aziz (1995) performed a series of tests to arrive at an acceptable bituminous mix using the incinerator residue material as a partial replacement for the aggregate. Durability, stability and resistance to moisture susceptibility tests were performed on the bituminous mixes. Incinerated residue with mixes showed higher values of stability and good resistance to moisture susceptibility.

The Authors recommended the use of incinerator residue passing sieve size (0.3 mm) to replace by granite aggregate in the design mix. The modified mix provides good stability to the mix and better moisture-resistance. The waste of incineration plant around 35 percent can use in mix design with the removing disposal problem.

Baig and Wahhab (1998) use of hematite (rock wool natural fibers) as filler in asphalt concrete pavements showed better resistance to fatigue and rutting than asphalt mix containing crushed stone filler..

Katamine (2000) tested three samples of wearing course mixes having oil shale fillers comparison standard mixture containing lime stone filler. The Marshall Test results indicated that the incorporation of oil shale fillers instead of limestone filler does not alter the optimum binder content of the mixes, increases the stability of the mixes.

Das Animesh and Pandey,B B (2000) The Economical design of bituminous concrete with two different grades of bitumen in the surfacing seminar on Road Construction, Operation and Design Highways in present Century.

Taha Etal. (2002) used Cement Bypass Dust (CBPD) as filler which is a byproduct of ordinary Portland cement industry in their study. Three different asphalt concrete mixtures were prepared using lime (control), and 5 and 13 % CBPD substitution for lime. Higher optimum bitumen content will require and uneconomical mix will create by the use of 13% CBPD for lime.

Ibrahim Asi and Abdullah Assa'ad (2006) fly ash produced after combustion of oil shale and Replacing 10% of the mineral filler by resulting ash gives improve the mechanical properties for all sample.

Hugo Bianchetto and Rodrigo Miró (2007) this paper explains the phenomena associated with bitumen aging and establish design patterns that contribute to optimum the agingsg resistance of bituminous mix with addition of calcareous fillers (limestone and hydrated lime filler). The fillers gives the best result in improve the aging resistance capacity.

Karasahin and Terzi (2007) used marble dust as filler material in asphalt concrete mixes. Lime stone dust and marble dust gave almost the same results on the basis of Marshall and plastic deformation tests. Marble dust has higher values of Marshall and plastic deformation than it suggested for low traffic roads. It was observed that maximum Marshall Stability of 15.4 KN was at 7.6% lime filler and the maximum compressive strength was 7.34 N/mm2 at 5% marble dust filler. The maximum tensile strength and the modulus of elasticity of the mix at 7.0% marble dust filler were 1.82 N/mm2 and 85.18 N/mm2., respectively

Sharma *et al*. (2010) fly ash has high amount of calcium oxide. Its presence governing the strength characteristics of bituminous mixes and fly ash up to 7 percent can be used as filler.

Ratnasamy Muniandy and Eltaher Aburkaba (2011) The mix of waste fillers(ceramic waste and coal fly ash) with bitumen mixes concrete confirms the fatigue property of asphalt mixture can be improved at lower stress levels. The waste fillers increase the fatigue life of SMA mixture.

Ravindra aithal. (2013) used silica flume and brick dust as filler it was observed that Marshall Properties were and enhanced. It can be used in construction of any flexible road.

Amir Modarres and Pooyan Ayar(2014) the fatigue life of the CRM mix containing 7% coal waste and coal waste ash was higher than that of containing 1% and 2% cement.

Prajapati Harshad and Dr. P. J. Gundaliya (2014) A Study on aging Behavior of Paving Grade Bitumen using Filler Material the physical properties of bitumen such as penetration, softening point and viscosity are improved with addition of cement. From results of penetration, cement added at 2% gives maximum Marshall Stability against aging effect.

Dipu Sutradhar and **Mintu Miah** (2015) result of using of waste concrete dust and brick dust as fillers in bituminous mix show that Marshall Stability values obtained almost same the of fine sand and stone dust to concrete dust

Saride, Sireesh and Avirneni, D and Javvadi (2015) it's observed that the balanced method of mixing would be more beneficial to get the strength and stiffness of the mixes the stabilizer by weight of principal material. The new design mix consisting of 80:20 proportion of Reclaimed asphalt pavement (RAP) and VA stabilized with 40 % fly ash by weight of the total mix, has met the design specifications laid down by Indian roads congress (IRC) for a base/sub base material of low volume roads.

Prof. S. B. Patil and Avinash A. Khot (2016) both waste materials fly ash and steel slag can be used in the preparing of bitumen mixes concrete for pavement.

Nazim Mohamed and Vitra Ramjattan-Harry (2016) Fly ash add to Trinidad Lake Asphalt (TLA) and Trinidad Petroleum Bitumen (TPB) improves the rutting resistance while decrease the fatigue cracks resistance at optimal dosages of fly ash below 2%.

Raja Mistry, Sandip Karmakar & Tapas Kumar Roy (2017) Results of Marshall stability, indirect tensile strength (ITR) and a tensile strength ratio show better performance of hot-mix asphalt (HMA) with the addition of rice husk ash (RHA) and fly ash (FA) compared to hydrated lime and also proved to be economical as the optimum bitumen content(OBC) is reduced by 7.5% from that of control mix with 4% filler ratio.

Hasan Taherkhani &Mohammad Reza Arshadi (2017) use of polyethylene terephthalate (PET) in asphaltic concrete with 2 %(by the weight of asphalt binder) gives the highest ITS, resistance against moisture damage Marshall and resistance against permanent deformation decreases with increasing the PET content.

N Saikrishna , G Mohanarao and PMS Satish Kumar (2018) It was observed that the physical properties plastic index, satisfying the specification for of bitumen mixes (Marshall Stability and flow value) improve with use of slag and brick dust as fillers with 2%, 3.5%, 5%, and 6.5% .

Mohamed samir Eisa and Mohamed E. Basiouny (2018) use of both Ceramic waste dust (CWD) and cement dust at 1:1 ratio to remove its plasticity. Lime stone dust was used as control filler. Subsequently, 17 hot-mix asphalt samples were prepared using the Marshall Stability method for wearing surface of bitumen (mix 4C). Marshall Stability (MS), flow tests, and flow values recorded by the specimens.

fisseha wagaw, prof. emer tucay guezon and enteneh geremew (2018) the result from laboratory for brick dust provides specific gravity , Marshall stability value and with filler in the warm asphalt mix so that brick dust can use as filler in hot bituminous mix design.

III FUNCTIONS OF DIFFERENT HIGHWAYS MATERIALS

Coarse aggregate:

The coarse aggregate should have good crushing strength, less water absorption capacity, abrasion value, and impact value. Its function is to bear the stresses coming from vehicles load. It has a good resist wear due to the abrasive action by traffic**.**

Fine aggregate:

It shall be fraction passing through 4.75 mm and retained on 75 microns sieve. Example crushed stone or natural sand. The Main function of fine aggregates to fill up the voids of the coarse aggregate.

Fillers:

The fillers should be inserted materials which pass through 75 micron sieve. Fillers may be limestone dust, cement, stone dust, brick dust, fly ash or pond ash and its function is to fill up the voids.

Bitumen:

It is not only a binding material but also water proofing material.

TESTS OF MATERIALS USED IN PAVING MIXES

Physical properties of aggregate recommended by MORTH 2011

S.No	Description of Test	Test Method	Test Result observed	MORT &H Specification Limit (Table No-500-17)
1	Elongation	IS:2386 Part I	20.54%	Max 40%
2	Flakiness	IS:2386 Part I	22.32%	Max 40%
3	Aggregate Impact value	IS:2386 Part 4	20.2%	Max 24%
4	Water Absorption	IS:2386 Part 3	1.34%	Max 2%

Bitumen test results

S.No.	Description of test	Test Method	Observed	Specific Limit
1.	Penetration value of Bitumen	IS : 1203	65.33	60-70
2.	Specific Gravity	IS 1202	1.03	0.99 Min

SPECIMEN PREPARATION

Sieve size analysis was done for 13.2 mm, 9.5 mm, and 4.75 mm size aggregate. Table 4.3 represents gradation of aggregate at different trials and combined grading of mix. In this project work, the MORTH gradation has been adopted.

Sieve Size in mm	% Pass	% to be used	% Pass	% to be used	% Pass	% to be used	% Pass	% to be used		Combined Grading Achieved
	13.2mm	44%	9.5mm	33%	4.75mm	18%	SD	5%	0%	100%
19.0	100.00	20.00	100.00	15.00	100.00	13.00	100.00	52.00	0.00	100.00
13.2	67.33	13.47	100.00	15.00	100.00	13.00	100.00	52.00	0.00	93.47
9.5	0.00	0.00	100.00	15.00	100.00	13.00	100.00	52.00	0.00	80.00
4.75	0.00	0.00	0.00	0.00	67.00	8.71	100.00	52.00	0.00	60.71
2.36	0.00	0.00	0.00	0.00	24.00	3.12	95.60	49.71	0.00	52.83
1.18	0.00	0.00	0.00	0.00	1.40	0.18	85.60	44.51	0.00	44.69
0.6	0.00	0.00	0.00	0.00	0.00	0.00	58.20	30.26	0.00	30.26
0.3	0.00	0.00	0.00	0.00	0.00	0.00	33.80	17.58	0.00	17.58
0.15	0.00	0.00	0.00	0.00	0.00	0.00	26.00	13.52	0.00	13.52
0.075	0.00	0.00	0.00	0.00	0.00	0.00	11.00	5.72	0.00	5.72

Table 4.4 Fractional weight of aggregate in Mix

Sieve Size	Combined Grading	Mid of Range	MORTH Specifications	% Fraction	Wt. in Material (gm)	Quantity (gm)	Aggregate Type
19.0	100.00	100.00	100.00	6.53	71.874	518.85	Coarse aggregate
13.2	93.47	89.50	90-100	13.47	148.13		
9.5	80.00	79.00	70-88	19.29	212.19		
4.75	60.71	62.00	53-71	7.88	86.658		
2.36	52.83	50.00	42-58	8.14	89.518	432.43	Fine aggregate
1.18	44.69	41.00	34-48	14.43	158.73		
0.6	30.26	32.00	26-38	12.69	139.57		
0.3	17.58	23.00	18-28	4.06	44.616		
0.15	13.52	16.00	12-20	7.80	85.8	148.72	Fly Ash/Brick Dust
0.075	5.72	7.00	4-10	5.72	62.92		

MARSHALL TEST RESULTS:

The results of the Marshall test of individual specimens and average Marshall Properties of specimens prepared with conventional materials as filler for varying bitumen contents have been presented in Tables 4.1 and 4.4 respectively.

Table No 4.1 Results of Marshall Test conventional materials

Bitumen 60/70%	Sample No.	Weight in air	Weight in water	Flow Value in mm	Stability Value Kilogram	G_t	Unit Weight g/cc	% air voids
5	1	1134	642	2.58	996	2.45	2.30	6.12
	2	1138	646	2.62	1334		2.31	5.71
	3	1128	638	2.40	1267		2.30	6.12
5.5	1	1145	655	2.63	1350	2.44	2.33	4.50
	2	1151	655	2.74	1440		2.31	5.32
	3	1131	648	2.68	1278		2.34	3.70
6	1	1148	662	3.52	1496	2.44	2.34	4.09
	2	1155	662	3.42	1463		2.33	4.11
	3	1164	668	3.48	1516		2.34	4.09
6.5	1	1162	666	3.68	1245	2.42	2.35	2.89
	2	1156	660	3.58	1367		2.33	3.71
	3	1152	664	3.55	1280		2.36	2.47
7	1	1168	669	3.75	1125	2.41	2.34	2.90
	2	1151	658	3.67	1060		2.33	3.31
	3	1147	654	3.79	1023		2.32	3.73

Table No 4.2 Average Marshall Properties of samples with conventional materials

Bitumen %	5	5.5	6	6.5	7
Marshall Properties					
Stability Kilogram	1199	1356	1491.66	1297.33	1185
Flow value (mm)	2.25	2.68	3.47	3.60	3.73
Unit wt (g/cc)	2.30	2.32	2.33	2.34	2.33
% air void	5.98	4.50	4.09	3.02	3.31
Volume of Bitumen	11.89	13.02	13.02	15.27	16.37
VMA (%)	17.87	17.52	17.11	18.29	19.68
VFB	66.46	74.31	76.09	83.48	83.18

Table 4.3 Optimum Binder Content conventional materials

S.No.	Marshall Parameters	Bitumen content %
1	Maximum Stability	6
2	VFB%	5.5
3	4% Air Voids	6

Optimum Binder Content by weight of total mix 5.50 %

Table 4.4 Check on specifications conventional materials

S. No.	Required specification of mix	Minimum Value as per MORTH	Obtained Value at OBC
1	STABILITY	900	1356
2	FLOW VALUE	2	2.68
3	AIR VOID	3	4.50
4	VFB (void filled by bitumen)	65	74.31
5	VMA (Void in mineral aggregate)	11	17.82

Table No 4.5 Results of Marshall Test (Specimens with fly ash)

Bitumen 60/70%	Sample No.	Weight in air	Weight in water	Flow Value in mm	Stability Value Kilogram	G_t	Unit Weight g/cc	% air voids
5	1	1134	631	1.7	980	2.445	2.251	7.93
	2	1146	638	1.9	1020		2.255	7.77
	3	1150	636	1.9	1080		2.233	8.67
5.5	1	1151	642	2.4	1140	2.440	2.260	7.37
	2	1143	640	2.1	1210		2.273	6.84
	3	1132	634	2.7	1370		2.271	6.92
6.0	1	1151	647	2.7	1360	2.435	2.281	6.32
	2	1145	645	3.1	1380		2.298	5.62
	3	1157	652	2.5	1420		2.295	5.74
6.5	1	1162	656	3.3	1290	2.430	2.295	5.55
	2	1154	646	3.4	1170		2.276	6.33
	3	1166	654	3.8	1235		2.273	6.46
7.0	1	1171	655	3.6	1165	2.420	2.261	6.57
	2	1168	650	3.8	1089		2.258	6.69
	3	1164	656	4.7	1156		2.290	5.37

Table No 4.6 Average Marshall Properties of samples with fly ash

Bitumen %	**5**	**5.5**	**6**	**6.5**	**7**
Marshall Properties					
Stability Kilogram	**1026.66**	**1240**	**1386.66**	**1231.66**	**1129**
Flow value (mm)	**1.83**	**2.41**	**2.76**	**3.5**	**4.03**
Unit wt (g/cc)	**2.24**	**2.26**	**2.29**	**2.28**	**2.26**
% air void	**8.12**	**7.04**	**5.89**	**6.11**	**6.21**
Volume of Bitumen	11.86	13.02	14.18	15.33	16.44
VMA (%)	19.98	20.06	20.07	21.44	22.65
VFB	59.359	64.90	70.65	71.50	72.58

Table 4.7 Optimum Binder Content for fly ash

S.No.	Marshall Parameters	Bitumen content %
1	Maximum Stability	6
2	VFB%	6
3	4% Air Voids	6

Optimum Binder Content found in Marshall Test by weight of total mix 5.66%

Table 4.8 gives value of the different required specification of mix taking fly ash as filler at 5.66 % binder content (OBC)

Table 4.8 Check on specifications fly ash

S. No.	Required specification of mix	Minimum Value as per MORTH	Obtained Value at OBC
1	STABILITY	900	1260
2	FLOW VALUE	2	2.51
3	AIR VOID	3	6.80
4	VFB	65	66
5	VMA	11	20.06

The results of the Marshall Test of individual specimens and average Marshall Properties of specimens prepared with Brick Dust as filler for varying bitumen contents have been presented in Tables 4.9 and 4.12.

Table No 4.9 Test results of Marshall Specimens (with brick dust as filler)

Bitumen 60/70%	Sample No.	Weight in air	Weight in water	Flow Value in mm	Stability Value	G_t	Unit Weight g/cc	% air voids
5	1	1132	642	2.3	1005	2.465	2.314	6.125
	2	1146	650	2.5	1011		2.317	6.004
	3	1141	646	2.1	1035		2.309	6.328
5.5	1	1153	657	2.4	1091	2.461	2.323	5.607
	2	1145	651	2.8	1086		2.315	5.936
	3	1130	644	2.9	1123		2.326	5.485
6.0	1	1158	663	3.4	1134	2.459	2.330	5.246
	2	1149	656	2.9	1156		2.335	5.042
	3	1140	653	3.6	1145		2.341	4.798
6.5	1	1165	668	3.1	1215	2.450	2.346	4.244
	2	1148	659	4.2	1234		2.343	4.367
	3.	1153	663	4.6	1245		2.352	4.000
7.0	1	1164	665	3.9	1170	2.440	2.337	4.221
	2	1155	663	4.8	1189		2.347	3.811
	3.	1160	663	5.8	1165		2.333	4.385

Table No 4.10 Average Marshall Properties of samples with Brick dust as filler

Bitumen %	5	5.5	6	6.5	7
Stability kilogram	1017	1100	1145	1231	1174
Flow value	2.3	2.7	3.3	3.96	4.83
Unit wt g/cc	2.313	2.321	2.335	2.347	2.339
% air void	6.152	5.676	5.028	4.20	4.13
Volume of Bitumen	11.96	13.14	14.32	15.46	16.58
VMA (%)	18.112	18.816	19.348	19.66	20.71
VFB	66.03	69.83	74.01	78.63	80.05

Table 4.11 gives binder contents at maximum stability, maximum unit weight and 4% air voids and optimum binder content (OBC).

Table 4.11Optimus Binder Content for brick dust

S.No	Marshall Parameters	Bitumen content %
1	Maximum Stability	6.5
2	VFB%	5.5
3	4% Air Voids	7

Optimum Binder Content found in Marshall Test taking brick dust by weight of total mix 5.95%

Table 4.12 gives value of the different required specification of mix taking brick dust as filler at 5.93% binder content (OBC)

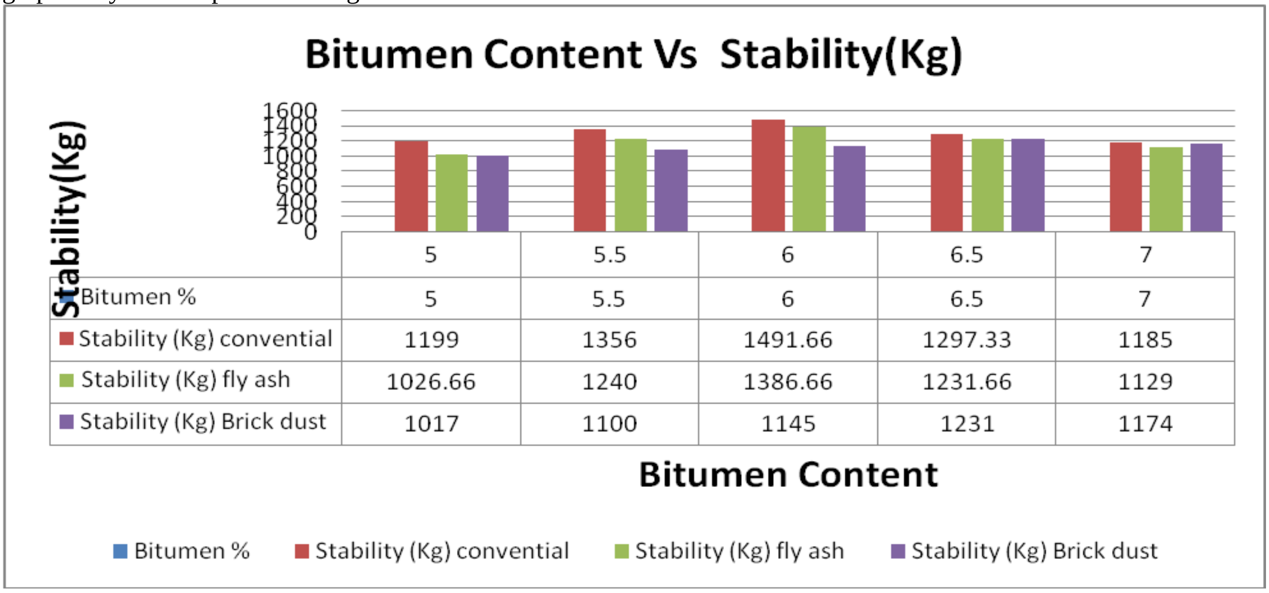
Table 4.12 Check on specifications brick dust

S. No.	Required specification of mix	Minimum Value as per MORTH	Obtained Value at OBC
1	STABILITY	900	1140
2	FLOW VALUE	2	3.5
3	AIR VOID	3	5.02
4	VFB	65	72.01
5	VMA	11	19.20

4.3 DISCUSSION OF TEST RESULTS

4.3.1 Fly ash and Brick dust specimen Marshall Curves

The results of Marshall Tests of specimens prepared with conventional materials given Table 4.1 to 4.4. Fly ash as filler given Tables 4.5 to 4.8 and specimens prepared with brick dust as filler given in Table 4.9 to 4.12 have been presented graphically for comparison in Figures 4.1 to 4. 6.



4.3.1.1 Marshall Stability

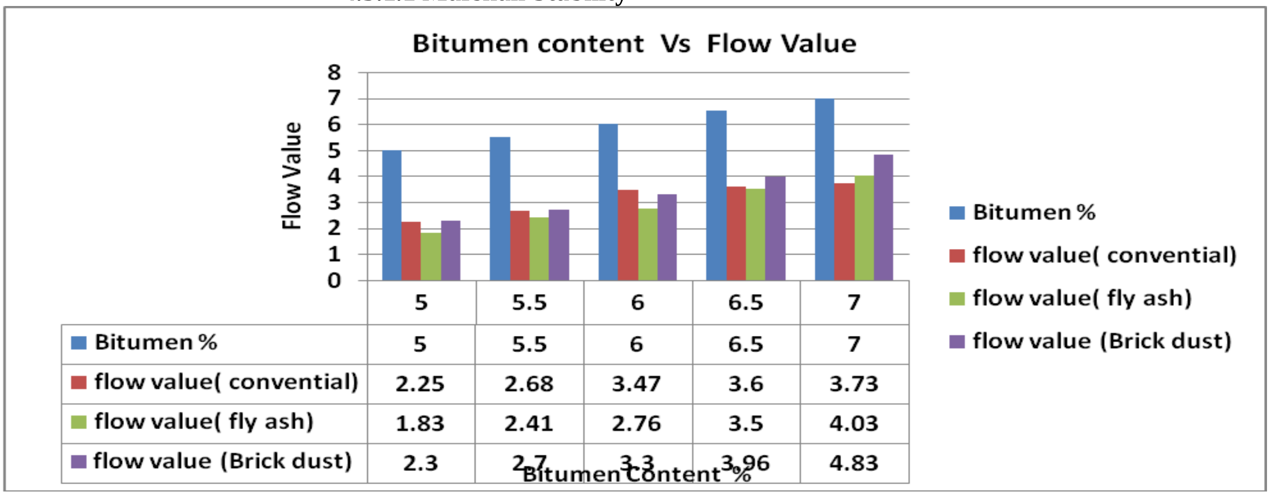


Fig 4.8 Marshall Test curves for Flow value

4.3.1.3 Marshall Unit weight curves (g/cc)

Fig 4.9 displays the graphical representation of unit weights for variation in percentage of bitumen content for Marshall Specimens having fly ash and brick dust as fillers.

In this figure brick dust specimens are found to display a higher unit weight in comparison with fly ash as filler due to lesser no of air voids in case of specimens having brick dust as filler, this may be due to brick dust acting as a filler material having better ability to fill up air voids than fly ash. In fly ash specimens maximum unit weight obtained is 3.5 g/cc at 6% bitumen content and brick dust specimens 2.34 g/cc at 6.5% bitumen content. Conventional aggregate specimens are found to display a highest unit weight 2.34 g/cc at 6.5 % bitumen content.

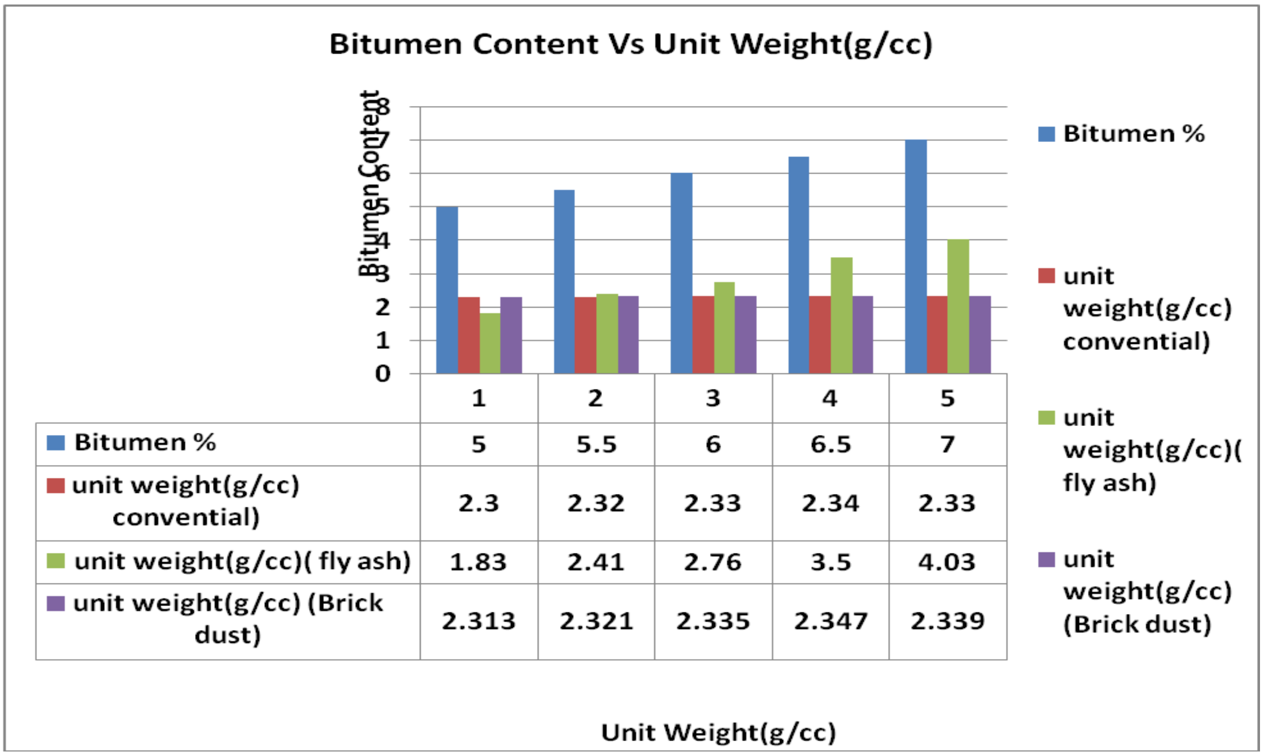


Fig 4.9 Marshall Test curves for Unit Weight (g/cc)

4.3.1.4 Marshall air voids (%) curve

Fig 4.10 shows the variation of air voids with variation in percentage of bitumen content with the minimum percentage of 5.89 % air voids being obtained at 6% bitumen content, however the curve obtained in brick dust specimen is found to have a decreasing trend displaying a greater bonding between brick dust and bitumen thus showing a decreasing trend in case of air voids with increase in asphalt content.

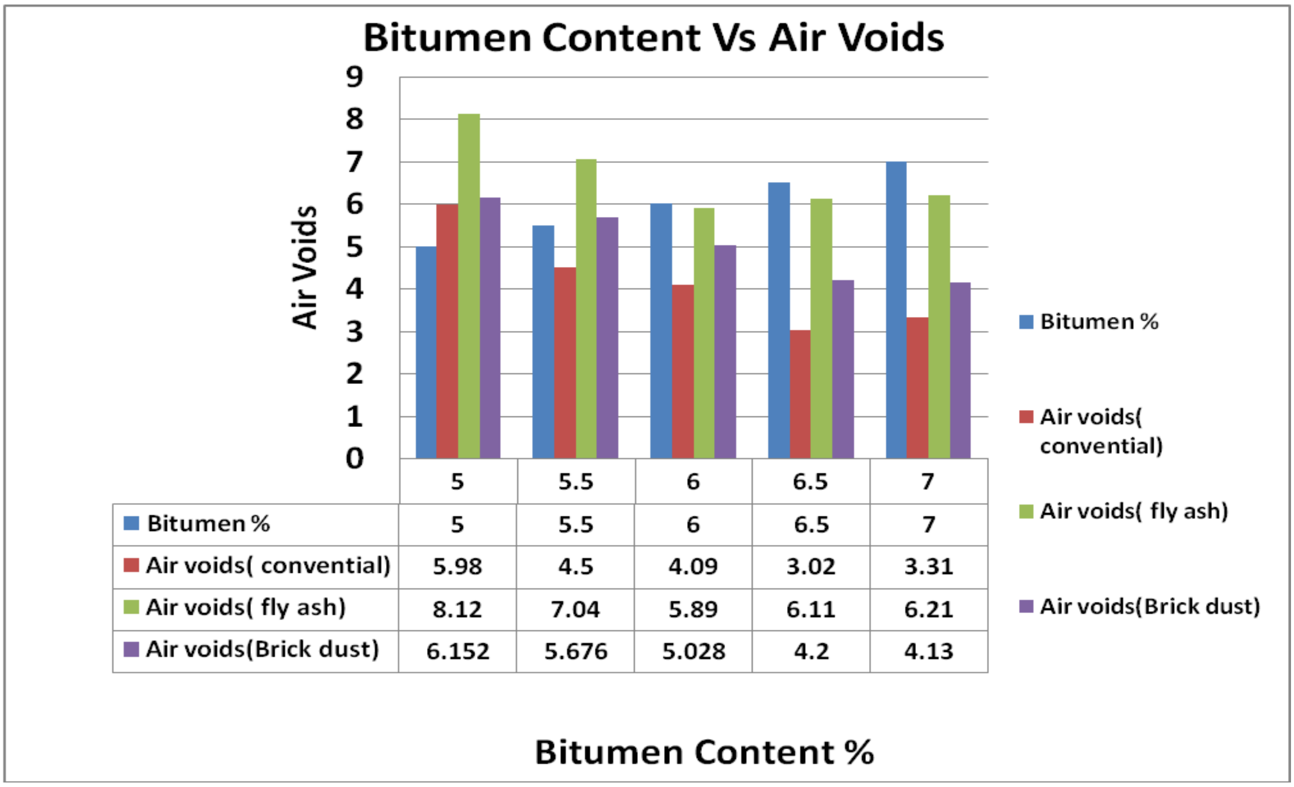


Fig 4.10 Marshall Test curves for Air void (%)

4.3.1.5 Marshall's VMA (%) curve

Fig 4.11 shows variation of VMA with varying bitumen content for specimen containing fly ash, brick dust, and conventional aggregates.

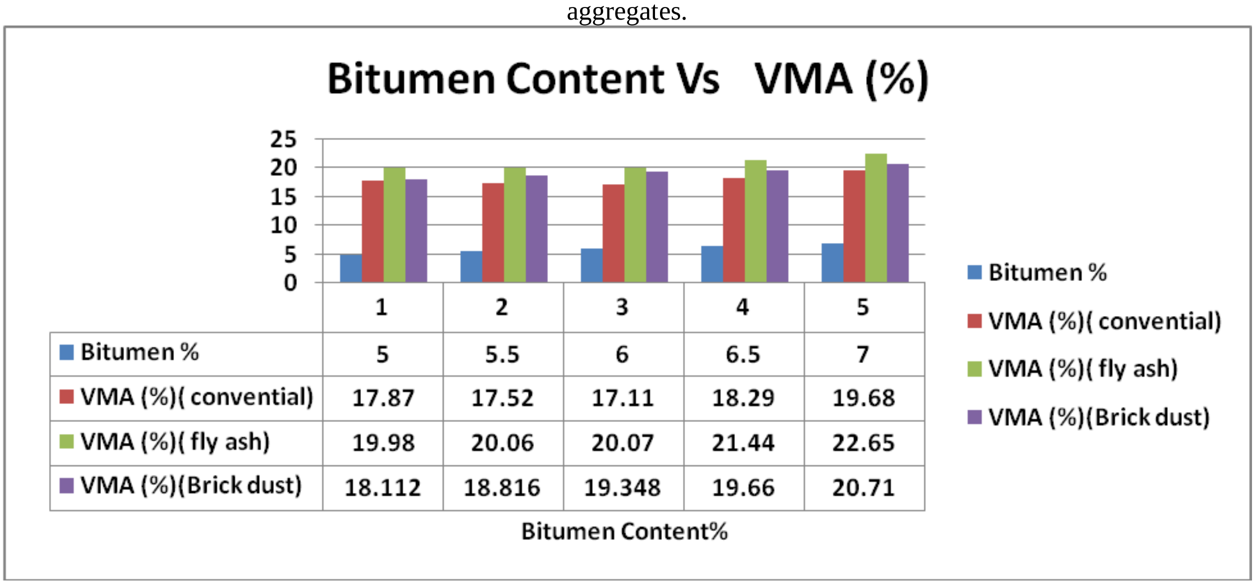


Fig 4.11 Marshall Test curves for VMA (%)

4.3.1.6 Marshall's VFB (%) curve

Voids filled by bitumen (VFB) increases with increase in binder content. Variation of VFB with different binder content is shown in fig 4.12 for specimen containing fly ash, brick dust and convention aggregate

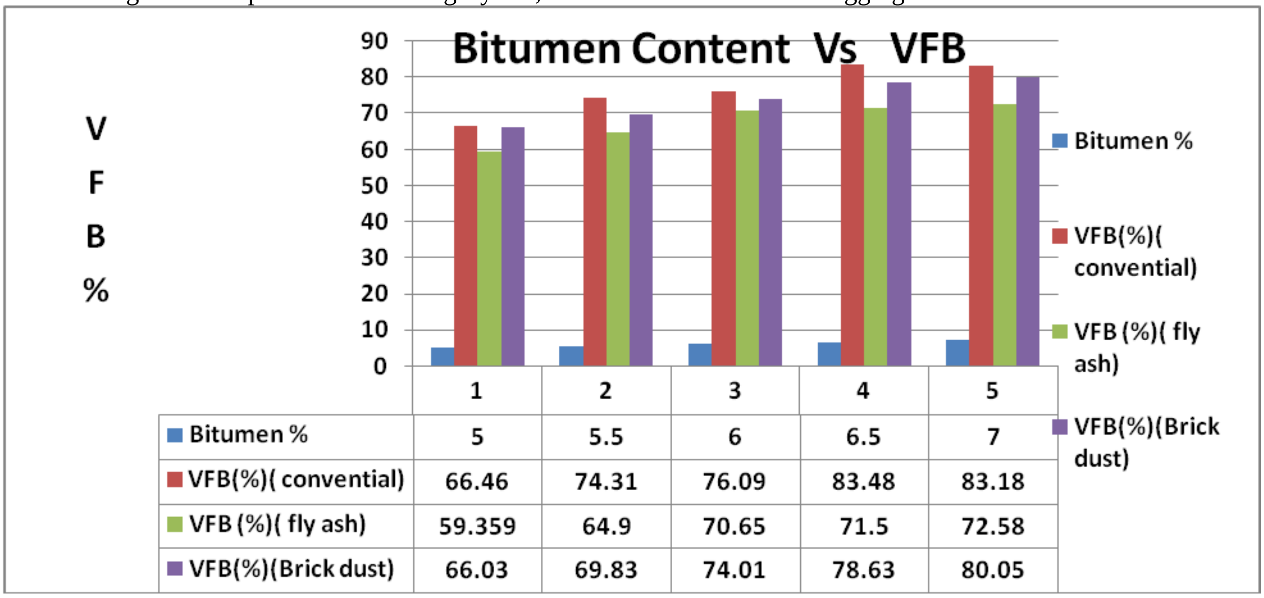


Fig 4.12 Marshall Test curves for VFB (%)

Table 4.13 Comparison of Results

S.No.	Parameters	Conventional Aggregate	Fly Ash	Brick Dust	MoRTH Specifications (Minimum)
1.	Optimum Binder Content (OBC) %	5.50	5.66	5.93	5.4
2.	Stability (Kg)	1491.6	1386.66	1231	
3.	Stability at OBC (Kg)	1356	1260	1140	900
4.	Flow Value at OBC mm	2.68	2.51	3.5	2
5.	Air Voids at OBC %	4.50	6.80	5.02	3
6.	VMA at OBC %	17.82	11	19.20	11
7.	VFB at OBC %	74.31	86	72.01	65

II. CONCLUSIONS

- Marshall Properties of bitumen mixes with Fly ash, and brick dust (waste material) is the same as mixes with lime and cement.
- Bituminous mixes having Fly ash as filler displayed two properties, first is maximum stability at 6% bitumen content and second is gradually decreased the ratio of bulk density & unit weight. The value of maximum stability obtained at the 6. 5% content of bitumen with brick dust as filler in Bituminous mixes & an ascending trend up till 6. 5% and then decreasing, the flow value showed an increasing trend and similar was the trend shown by the ratio of unit weight & bulk density, percentage of air voids will decrease with increasing in bitumen content, and we obtained suitable results at 6. 5% bitumen content.
- We get the High Value of Air voids of modified asphalt mixes with fly ash, and brick dust than normal mixes..
- Higher Bitumen the percentage will be more required to find out the design criteria for pavement design as normal design.
- We can use of fly ash, and brick dust (Waste materials) in the asphalt pavement construction, as usual, other waste material.
- Use of fly ash, and brick dust as fillers in bituminous asphalt road to solving the problem the disposal of industrial and construction wastes for further modification.
- Use of fly ash, and brick dust as fillers in the bituminous pavement are much cost-effectiveness, which can be realized after performing the experiments study against the use of lime and cement.

5.2 Recommendations

- Crumb Rubber Modified Bitumen having the Similar properties of bitumen mixes with brick dust and fly ash.
- The tensile strength of the bituminous mixes can be easily determined by the procedure of Indirect tensile test.
- The value of fatigue failure can find out through Repeating stresses on the bitumen samples.

5.3 scopes

- For further studies Uses more quantities of fly ash in bituminous concrete in the flexible pavement because fly ash is a waste burned material and free in 100 km. From the thermal plant.
- Use a mere quantity of brick dust in future research and find out the result of bituminous concrete.

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