International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 4, April 2017, pp. 1305–1312, Article ID: IJCIET_08_04_147
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=4
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

USAGE OF WASTE MATERIALS IN PAVEMENT CONSTRUCTION WITH REPLACEMENT OF CONVENTIONAL MATERIALS

Sravanth B Sambaturu, Surendra Y.L
UG- student, Department of Civil Engineering, K L University,
Vaddeswaram, Andhra Pradesh, India

T. Nagaseshu Babu, K. Hemantha Raja
Assistant Professor, Department of Civil Engineering, K L University,
Vaddeswaram, Andhra Pradesh, India

SS. Asadi
Professor & Associate Dean Academics, Department of Civil Engineering,
K L University, Vaddeswaram, Andhra Pradesh, India

ABSTRACT

The quantum of plastic waste in municipal solid waste and shortage of the natural aggregates is gradually increases due to increasing of population, urbanization, development activity & change in life style. As waste plastic and cement concrete materials are non-biodegradable elements are major problem posed to society and with regarding to management of these waste materials. These waste materials elements are now a challenge to dispose. So, we can replace these waste materials that of using of low density polythene (LDPE) and old demolish concrete structures as the replacements in conventional materials used in construction of pavement. The polymer can be formed by a wide variety of thermoplastic processing methods and is particularly useful where moisture resistance and low cost are required. Vinyl acetate can be copolymerized with ethylene. For alternate use of cement filler we use GGBS (ground granulated blast furnace slag).

Key words: GGBS, Plastic,, Recycled Aggregates.

Cite this Article: Sravanth B Sambaturu, Surendra Y.L, T. Nagaseshu Babu, K. Hemantha Raja, SS. Asadi, Usage of Waste Materials in Pavement Construction with Replacement of Conventional Materials. *International Journal of Civil Engineering and Technology*, 8(4), 2017, pp. 1305–1312.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=4

1. INTRODUCTION

The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favourable light reflecting characteristics, and low noise pollution.

The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of the sub-grade. Two types of pavements are generally recognized as serving this purpose, namely flexible pavements and rigid pavements.

An ideal pavement should meet the following requirements:-

- Sufficient thickness to distribute the wheel load stresses to a safe value on the sub-grade soil,
- Structurally strong to withstand all types of stresses imposed upon it,
- Adequate coefficient of friction to prevent skidding of vehicles,
- Smooth surface to provide comfort to road users even at high speed,
- Produce least noise from moving vehicles,
- Dust proof surface so that traffic safety is not impaired by reducing visibility
- Impervious surface, so that sub-grade soil is well protected, and
- Long design life with low maintenance cost.

Plastic use in road construction is not new. Recent studies in this direction have shown some hope in terms of using plastic waste in road construction i.e. plastic roads. Plastic roads mainly use plastic carry bags, disposable cups and PET bottles that are collected from garbage dumps as an important ingredient of the construction material. When mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar road. The crushing characteristics of hardened concrete are similar to those of natural rock and are not significantly affected by the grade or quality of the original concrete. Recycling of concrete is a relatively simple process. It involves breaking, removing, and crushing existing concrete into a material with a specified size and quality. An attempt has been made in this investigation to assess the influence of non-conventional and cheap fillers such as brick dust and fly ash in bitumen paving mixes. It has been observed as a result of this project that bituminous mixes with these non-conventional fillers result in satisfactory. As a result of all non-conventional materials used in the construction of pavement is enhance the character tic properties of pavement which we can analysis the design of pavement in by doing the Marshall Stability test.

1.1. Objectives

- Reduction of usage of petroleum products and natural available materials by increasing the usage of waste material in surroundings.
- To study basic properties of aggregates, recycled aggregates and bitumen with plastic
- To study the strength and stability characters of BC Mix with non-conventional materials.

2. METHODOLOGY

Procedure to determine Marshall Stability of bituminous mixture

- Select aggregate grading to be use in binder mix suing MoRTH table
- Determine the proportion of each aggregate size required to produce the design
- Grading.
- Determine the specific gravity of the aggregate combination and asphalt cement.
- Prepare the trial specimens with varying asphalt contents.
- Determine the specific gravity of each compacted specimen.

- Perform stability tests on the specimens.
- Calculate the percentage of voids, and percent voids filled with Bitumen in each Specimen.
- Select the optimum binder content from the data obtained.
- Evaluate the design with the design requirements.

Following Tests were conducted to investigate the properties of the aggregate as well as Bitumen.

2.1. Tests on Aggregate

- Sieve analysis of aggregates [IS2386 Part 1]
- Specific Gravity & Water Absorption Test [IS: 2386 (Part 3) 1963]
- Aggregate Impact Value Test [IS: 2386 (part 4) 1963]
- Aggregate Crushing Value [IS: 2386 (Part 4) 1963]
- Flakiness & Elonga0tion Index Test [is: 2386 (part 1) 1963]

2.2. Tests on Bitumen

- Penetration Test [Is: 1203-1978]
- Softening Point Test [Is: 1205-1978]
- Ductility Test [IS: 1208-1978]
- Viscosity Test[IS 1206 (part2)]
- Flash Point and Fire Point[IS 1209-1978]

2.3. Experimental Work

Find out the properties of aggregates, bitumen and bituminous mix and then find the (OBC) optimum bitumen content from the samples prepared in the lab and then proceed to replace of the materials in the certain percentages of plastic, Recycled aggregates and GGBS in bitumen, aggregates and filler materials.

Aggregates influence, to a great extent, the load transfer capability of pavements. Hence it is essential that they should be thoroughly tested before using for construction. Not only that aggregates should be strong and durable, they should also possess proper shape and size to make the pavement act monolithically. Aggregates are tested for strength, toughness, hardness, shape, and water absorption.

Requirements of bitumen as a binding material and its different forms were discussed. Various tests are conducted on bitumen to assess its consistency, gradation, viscosity, temperature susceptibility, and safety. Standard test procedures on bitumen were also covered according to code books specified above.

3. SAMPLE PREPARATION

Mixture Designs were performed using the Marshall method by preparing and compacting samples with Bitumen content varied in 0.5% increments according to ASTM Test Method for Resistance to Plastic Flow of bituminous Mixtures Using Marshall Apparatus. Grade 60/70 Bitumen binder. Specimens were compacted with 75 blows on each side. Three samples were made for each Bitumen content. The optimum Bitumen content was chosen as the Bitumen content that produced 4% air voids. Further, two types of void were calculated for the compacted samples: the void in mineral aggregate (VMA),The VCA‟s were

calculated in a way similar to the VMA‟s by replacing percent of aggregate in the mix with percent of coarse aggregate in the calculation

4. RESULTS AND DISCUSSION

4.1. Tests on Aggregates

Aggregates that are taken for the analysis of the construction of pavement are given in below table 1 with comparison of standard acceptable values according to their particular code specified in above chapter 2.1

Table 1 Physical characteristic of aggregate with comparison of standard values

S.no	Tests	Results	Acceptable value
1.	Aggregates Crushing Value	26.4%	30%
2.	Impact Value	20.2%	10-20(Strong) 20-30(Good)
3.	Specific Gravity	2.8	2.5-3
4.	Water Absorption	0.36	0.1-4%
5.	LosAngeles Abrasion Test	34.2%	30%

4.2. Tests on Bitumen

Bitumen that are taken for the analysis of the construction of pavement are given in below table 2 with comparison of standard acceptable values according to their particular code specified in above chapter 2.2

Table 2 Physical characteristics of bitumen with comparison of standard values

S.no	Tests	Results	Acceptance value
1.	Ductility	76	75(Min)
2.	Ring & Ball Test (Softening Point)	67	47(Min)
3.	Penetration	55	-
4.	Flash And Fire Point	238^0c (Fire) 218^0c (Flash)	- -

4.3. Tests on Recycled Aggregates

Aggregates that are taken for the analysis of the construction of pavement are given in below table 3 with comparison of standard acceptable values according to IRC specifications

Table 3 Physical Properties of the Aggregates with comparison of conventional aggregates

S.NO	Test on Aggregates	Recycled Aggregate	Natural Aggregate	IRC specification
1	Aggregate crushing test (%)	22.75	26.07	Max. 30
2	Los Angeles Abrasion test (%)		36.9	Max. 30
3	Impact test (%)	12.67	16.2	10-20 (strong) 20-30 (good)
4	Water absorption	0.5	0.4	1
5	Specific Gravity	2.62	2.89	2.6-2.9

4.4. Mix Design Proportions

Mix proportions that are taken in this project of different types of variation of proportion of plastic with respectively variation of proportion of recycled aggregates.

Table 4 Mix proportional of samples

Sl. no	Mix name	Percentage of natural aggregates	Percentage of recycled aggregates
1	C	100	-
2	M1	85	15
3	M2	80	20
4	M3	75	25

For variation of bitumen content used in mix proportion C the characteristic stability values of mix sample is given below table 5

Table 5 Characteristic values of conventional materials

Mix	Percentage bitumen	Avg. Marshall Stability	Flow	Unit weight	%voids in total mix	%voids in filled by bitumen
C	5	1786.5	4.41	2.55	5.5	78
	5.5	2119.52	4.83	2.63	3.8	82.9
	6	2055.04	5.75	2.48	3	80

For variation of replacement of aggregate with natural aggregate of 15% and variation of plastic of optimum replacement of sample mix M1 is given below table 6

Table 6 Characteristic values of recycled aggregate for 15% replacement and optimum plastic replacement

Mix	Percentage bitumen	Avg. Marshall Stability	Flow	Unit weight	%voids in total mix	%voids in filled by bitumen
M1	5	1366.225	2.25	2.5	4.4	78.3
	5.5	2121.645	3.19	2.57	3.3	81.04
	6	2196.806	3.7	2.46	3.125	78.5

For variation of replacement of aggregate with natural aggregate of 20% and variation of plastic of optimum replacement of sample mix M2 is given below table 7

Table 7 Characteristic values of recycled aggregate for 20% replacement and optimum plastic replacement

Mix	Percentage bitumen	Avg. Marshall Stability	Flow	Unit weight	%voids in total mix	%voids in filled by bitumen
M2	5	1664.98	2.48	2.5	4.6	78.1
	5.5	2183.48	3.23	2.53	3.2	82.9
	6	2250.0	3.9	2.47	3	78.59

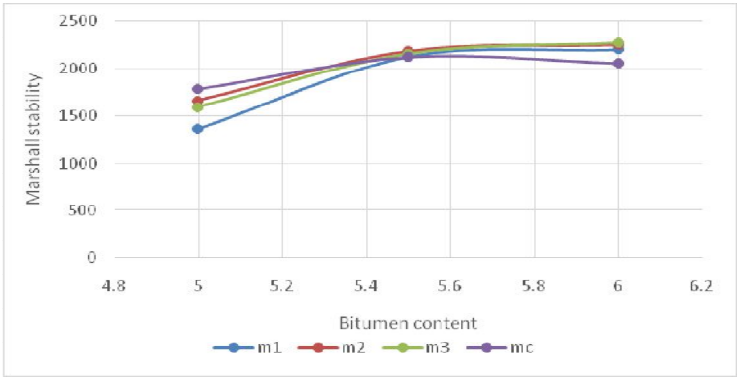
For variation of replacement of aggregate with natural aggregate of 15% and variation of plastic of optimum replacement of sample mix M3 is given below table 6

Table 8 Characteristic values of recycled aggregate for 25% replacement and optimum plastic replacement

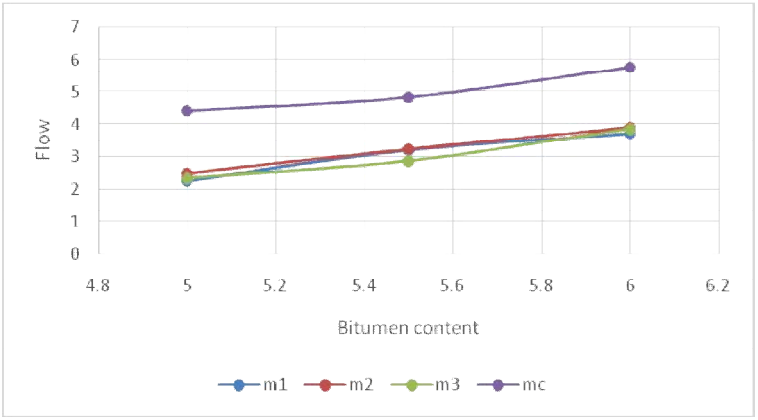
Mix	Percentage bitumen	Avg. Marshall Stability	Flow	Unit weight	%voids in total mix	%voids in filled by bitumen
M3	5	1597.418	2.34	2.53	5.5	78.1
	5.5	2158.75	2.85	2.54	4.1	83.1
	6	2271.967	3.58	2.48	3.6	78.6

5. GRAPHS

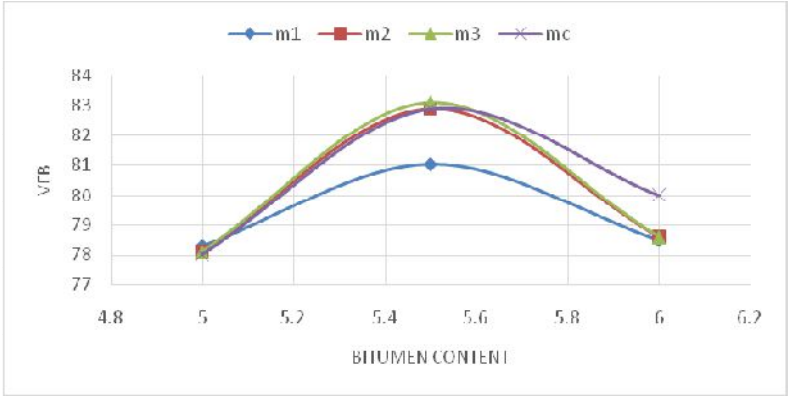
Variation of stability values with comparison of conventional and non-conventional materials



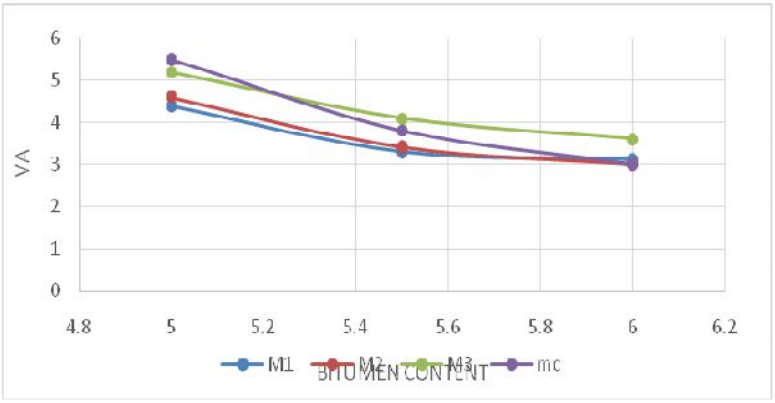
Variation of flow values of mix with comparison of conventional and non-conventional materials



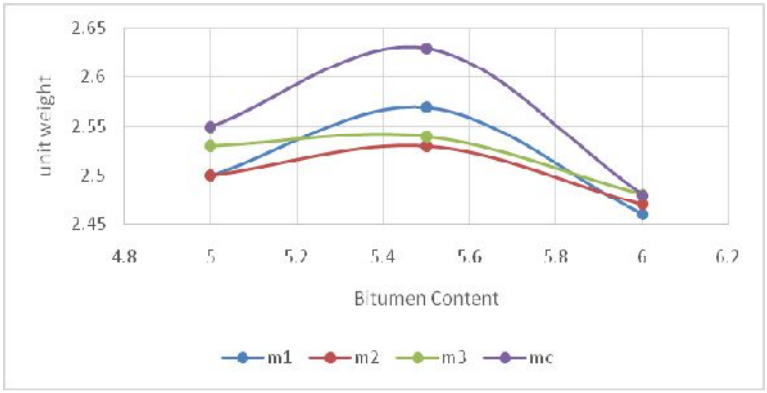
Variation of void filled bitumen (VFB) values with comparison of conventional and non-conventional materials



Variation of void aggregates (VA) values with comparison of conventional and non-conventional materials



Variation of unit weight mix values with comparison of conventional and non-conventional materials



The physical, chemical and strength characteristics of various waste materials like building construction and debris (Recycled aggregates),Steel & Blast furnace slag were tested in laboratory and with respectively of conventional materials. The results were found to be within the specified limits as per MoRTH**.**

- Recycled aggregates found to be relatively soft compared with conventional aggregates and can be used as a sub base material but not in wearing course. Here the taken Recycled aggregates are found to be within the limits as per MoRTH specifications.
- The addition of plastic modifiers enhance the properties of bitumen which we see in the above experimental works and results
- It is observed that GGBS as filler have almost same properties as conventional filler properties
- For the optimum replacement of conventional materials with non-conventional materials(waste materials) of plastic 4%, recycled aggregate 20% and filler as GGBS we get 27.78% more stability values compared to conventional use materials as mentioned at graph 5.1 and reduction of voids in the mix is also given in graph 5.3

REFERENCES

[1] Al-Hadidy A.I. and Yi-qiu T. (2009), “Effect of polyethylene on life of flexible pavements”, Journal of Construction and Building Materials, volume 23, India

[2] Attaelmanan M., Feng C. P. and AI A. (2011), “Laboratory evaluation of HMA with high density polyethylene as a modifier”, Journal of Construction and Building Materials.

[3] Awwad M. T. and Shbeeb L (2007), "The use of polyethylene in hot asphalt mixtures", American Journal of Applied Sciences, India

[4] Annette R. Hill, Andrew R. Dawson, Michael Mundy.,(2001), "Utilisation of aggregate materials in road construction and bulk fill", Resources, Conservation and Recycling, Vol. 32, School of Civil Engineering, University of Nottingham, Australia

[5] Aravind K. , Das Animesh, (2007), "Pavement design with central plant hot-mix recycled asphalt mixes", Construction and Building Materials, Vol. 21, Dept. of Civil Egg., Indian Institute of Technology Kanpur, India

[6] American Association of State Highway and Transportation Officials (AASHTO), "Standard specification for mineral filler for bituminous paving mixtures", USA, Washington DC, M07 – 17, (1997)

[7] American Society for Testing and Materials (ASTM), "ASTM-C618: Standard specification for fly-ash and raw or calcined natural pozzolan for use as mineral admixture in Portland cement concrete, annual book of ASTM standards", USA, Pennsylvania, West Conshohocken, 2005.

[8] Akbulut H, G¨urer C (2007). Use of aggregates produced from marble quarry waste in asphalt pavements. Building and Environment.

[9] Brown, E.R., McRae, J.L, and Crawley, A.B. (1989) Effect of aggregate on performance of bituminous concrete. ASTM STP 1016, Philadelphia

[10] Bandopandhyay T. K., (Jan. - Mar. 2010), "Construction of Asphalt Road with Plastic Waste", Indian Centre for Plastic in Environment (ICPE), ENVIS – Eco- Echoes, Vol.11, Issue 1.

[11] D. Sakthibalan (2007) Influence of Aggregate Flakiness on Dense Bituminous macadam & Semi Dense Bituminous Concrete Mixes

[12] Das Animesh and Pandey B (2000),"Economical design of bituminous pavements with two grades of bitumen in the surfacing", seminar on Road Financing, Design, Construction and Operation of Highways in 21st Century

[13] A. Rahman, S. A. Ali, S. K. Adhikary, and Q. S. Hossain, (2012) "Effects of fillers on bituminous paving mixes: An experimental study. Journal of Engineering Science, Vol. 3 (1), pp. 121 – 127

[14] IS Indian standard paving bitumen -specification, 2nd Rev., New Delhi, India, Bureau of Indian Standards, 73, (1992).

[15] Guidelines for the design of flexible pavement (IRC 37-2001), Indian Road Congress, second revision, New Delhi

[16] Specifications for road and bridge works, ministry of Road Transport Highways, fifth revision, section 500, Indian Roads Congress. New Delhi, 2013