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TO DETERMINE THE STABILITY OF CONVENTIONAL MIX BY "CRUMB RUBBER MODIFIED BITUMEN"

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ABSTRACT

A proper road network contributes to the growth of country and with time the construction of highways roadways and pavements is increasing and the construction requires huge sums of money and after sometime these pathways require maintenance and repair also. And with the increasing trend of green technology in civil engineering construction, recycling of waste material for construction purpose is encouraged. One such material is crumb rubber which is non-biodegradable and when disposed in dumping sites release toxic chemicals into the ground affecting its properties or when burnt release harmful gases that cause severe problems such as green house effect, global warming and ozone layer depletion. The crumb rubber mixed bitumen reduces the cost of construction and increases the durability and lifespan of the roads and pavements by enhancing its various properties and also provides a method for proper disposal of waste tyre rubber without any harmful effects. This study provides an idea for the use of crumb rubber mixed bitumen.

KEYWORDS: Pavements, Crumb rubber, Non-biodegradable, Toxic chemicals, Durability.

I. INTRODUCTION

Crumb rubber modified bitumen is coming up as an essential construction materials for flexible pavements. The crumb rubber modified bitumen exhibit better properties for road construction and provides a proper disposal method for waste tyre rubber without causing any pollution. In flexible pavement construction the CRMB plays the role of binding the aggregate by coating the aggregate, this improves the strength of the road but water resistance is poor. The CRMB is a binder obtained by mixing bitumen with crumb rubber produced by recycling of used tyres and some specific additives. The CRMB offers wide flexural range and is suitable for pavements which are exposed to different weather condition such as highways, bridge roads, sea port roads etc. It is a reliable and inexpensive solution for flexible pavement construction and maintenance of damaged or wearing pavements. In this study the percentage of crumb rubber will be varied from 5% to 15% with an increment of 5% and the properties of CRMB will be studied for the different percentages. Crumb rubber is a commonly used additive for pavement construction and it has been used in various highway applications for more than 50 years. Generally, the tyre rubber is grind to a particular size of the crumb after which it is added to the bitumen. This form of tyre rubber is called crumb rubber modifier which upon adding with bitumen is known as CRUMB RUBBER MODIFIED BITUMEN. The CRMB increases the fatigue property of the mix to be used for the construction as well as improves the adhesion between the aggregate and the binder resulting in the prevention of cracking and reflective cracking in the pavement courses.

II. OBJECTIVE

The main objectives of this research paper are as follow-

1. To replace bitumen by different percent of CRMB.
2. To design crumb rubber modified bitumen pavement.
3. Evaluate the impact of aggregate gradation and bitumen content on marshall mix.
4. Evaluate the stability of bitumen by mixing crumb rubber.
5. To notice the difference between CRMB and normal bituminous mix.

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III. ANALYSIS OF MATERIAL

1. CRUMB RUBBER :

Rubber from waste tyres is grind to form powder like substance, this powder form is known as crumb rubber modifier. It has been used in highway works for more than over 40 years. The waste tyres are collected from dump sites, scrap dealers, puncture shops etc. The rubber is crumbed to a size of about 425 micron for our study.

2. AGGREGATE :

A) COARSE AGGREGATE:

The coarse aggregate should include rock sediments, gravel and other hard material retained on 2.36 mm sieve. The coarse aggregate to be used for pavements construction should posses high strength, toughness , hardness , Proper shape and should be highly durable.

B) FINE AGGREGATE :

The fine aggregate consists of sediments of rock that passes the 2.36mm sieve and retained on 75 micron sieve. Generally round shape is desired for fine aggregate. The plasticity index of fraction passing the 0.425mm sieve should not be greater than 4%.

The gradation of aggregate & binder content as per

MORTH Composition of bituminous concrete pavement layer

Table-3.1: Grading as per MoRT&H Specification

Grading	1	2
Nominal aggregate size	19 mm	13.2 mm
Layer thickness	50 mm	30-40 mm
IS Sieve (mm)	Cumulative percentage by weight of total aggregate passing	
45.0	-	-
37.5	-	-
26.5	100	-
19.0	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
0.60	15-27	26-38
0.30	10-20	18-28

0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Minimum 5.2	Minimum 5.4

3. BITUMEN :

As per IS:73 specification the bitumen to be used should be viscosity graded paving bitumen. The type and grade of bitumen is selected on the basis of climatic condition and traffic over the pavement. The results of test performed in the laboratory are shown below-

Table-3.2: Specification of Test of bitumen

Property tested	Specification	Result
Penetration (100 g, 5 sec at 25**0**C) (1/10**th** of mm)	IS 1203-1978	60
Softening Point , **0**C (Ring & Ball Apparatus)	IS 1205-1978	55
Ductility at 27**0**C (5 cm /min pull), cm	IS 1208-1978	62

Selection for viscosity grade bitumen, depend on highest and lowest daily mean temperature at a particular site are given..

Selection criteria for VG based on climatic condition

Table-3.3: Specifications dependent on Temperature

Lowest daily mean air temperature ^{0}C	Highest Daily Mean Air Temperature, ^{0}C		
	Less than 20^{0}C	20 to 30^{0}C	More than 30^{0}C
More than -10^{0}C	VG-10	VG-20	VG-30
-10^{0}C or lower	VG-10	VG-10	VG-20

4. FILLER :

The filler should be a fine material such as rock powder or cement and should be free from organic impurities.

IV. TESTING OF MATERIAL

4.1.0. TESTING OF AGGREGATE-

4.1.1 Water Absorption Test-

The property of water absorption gives information about the internal structure of the aggregate. Greater the absorption greater is the porosity of aggregate and aggregate with higher porosity is not considered suitable unless it has high strength or toughness.

4.1.2 Impact Value Test-

In impact value test the property of toughness (i.e the ability to resist impact or shock) is measured. The test helps to classify the aggregate for different pavement construction according to the impact value. As per MORT&H specification the maximum permissible value of impact test is 24%. The impact value of aggregate is calculated as follow-

Impact value = W2/W1*100

Here W1 = Weight of sample dried in oven

W2= Weight of sample that pass through the 2.36MM sieve after 15 hammer blows

4.1.3 Specific Gravity Test-

Specific gravity is the ratio between weight of aggregate to weight of an equivalent amount of water. The measure of specific gravity determines the quality and strength of material. Aggregate having lower value of specific gravity have less strength than those having higher value.

4.1.4 Abrasion Value Test-

This test is done to calculate the aggregates toughness and resistance against crushing and wearing. As per MORT&H specification the value of this test should not exceed 30%.

4.1.5 Crushing Value Test-

This test measures the resistance offered by the aggregate when exposed to gradually applied load. It gives a numerical value of strength of aggregate and whether it is suitable for road and pavement construction. Lower crushing value indicates higher strength and if value is greater than 30% it is not considered suitable.

4.1.6 Flakiness and Elongation Index-

The flakiness test is not suitable for size of aggregate smaller than 6.3MM. And it is the percentage by weight of particles whose thickness is less than 0.6 times of its mean dimensions.

The elongation test is also not suitable for size of aggregate smaller than 6.3MM. And it is the percentage by weight of particles whose length is greater than 1.8 times their mean dimension.

4.2.0 TESTING OF BITUMEN-

For this study the bitumen of viscosity grade 30,VG-30,is used in modified as well as conventional mix as a bituminous binder. The result of test conducted are as follow-

Table-4.1: Bitumen Ductility Test

S.No.	DESCRIPTION	Sample no.	
		I	II
1	Initial reading (A)	0	0
2	Final reading (B)	76.8	75.8
3	Ductility = B-A ,cm	76.8	75.8
Mean ductility value ,cm			76.4

4.3.0 MARSHALL MIX DESIGN-

The marshal l mix design calculates the optimum bitumen content for bituminous mix. It includes stability and flow calculation. The stability part calculates the maximum load at which the test specimen fails when loading is done at the rate of 50.8mm per minute and that load is termed as stability. In the flow part of the process a dial gauge measures the deformation in the specimen in an increment of 0.25mm at the time of loading. The deformation at maximum loading is termed as flow value

4.3.1 Specimen Preparation-

At a temperature between 175^0c-190^0c**,** a mixture of 1200 gram of aggregate and filler is heated and bitumen is heated at a temperature about 125^0c with trial percentage of bitumen about 4%. Then the heated bitumen and aggregate are mixed with each other at a temperature of about 160^0c.After this the mixture is transferred to a preheated mould and compacted by a rammer by giving 50 blows at a temperature of 150^0c.The thickness of the mix should be around 63.5mm and for that purpose the weight of aggregate and the bitumen content can be altered.

After the preparation of mix, the mould is ready to be tested and is loaded on the Marshall test setup which calculates the values of stability and flow. The results obtained from this test are noted and presented in a tabulated form.

V. RESULTS AND OBSERVATIONS

5.1.0 Marshall Test observations

Table-5.1: Grading1 Middle; Binder - virgin VG30; Mix type Normal

Properties	% Bitumen Binder				
	5.2	5.4	5.6	5.8	6
Bulk Density(gm/cc)	2.45	2.47	2.48	2.71	2.59
Air Voids(%)	4.76	3.66	2.96	2.73	2.59
VMA	17.39	16.89	16.73	16.98	17.30
VFB	71.60	73.28	75.26	78.88	80.02
Stability(KN)	12.10	12.86	13.24	11.33	9.81
Flow(mm)	2.94	3.32	3.66	3.92	4.84

Table-5.2: Grading1; Binder-Crumb Rubber Modified VG30 with 5% crumb rubber; Mix type Modified

Properties	% Bitumen Binder (CRMB)				
	5.2	5.4	5.6	5.8	6
Bulk Density(gm/cc)	2.45	2.47	2.49	2.50	2.49
Air Voids(%)	4.48	3.68	2.74	2.19	2.06
VMA	17.24	16.68	16.31	16.28	16.61

VFB	71.92	73.98	74.18	77.50	79.55
Stability(KN)	12.62	14.73	16.04	13.95	12.36
Flow(mm)	2.98	3.17	3.96	4.50	5.34

Table-5.3: Grading1; Binder-Crumb Rubber Modified VG30 with 10% crumb rubber; Mix type Modified

Properties	% Bitumen Binder (CRMB)				
	5.2	5.4	5.6	5.8	6
Bulk Density(gm/cc)	4.45	2.48	2.50	2.50	2.49
Air Voids(%)	4.76	3.36	2.26	2.19	2.06
VMA	17.17	16.40	15.89	16.28	16.61
VFB	70.27	72.47	77.74	80.50	81.55
Stability(KN)	13.22	15.64	17.51	14.78	12.89
Flow(mm)	2.93	3.16	3.78	4.49	5.01

Table-5.4: Grading1; Binder-Crumb Rubber Modified VG30 with 15% crumb rubber; Mix type Modified

Properties	% Bitumen Binder (CRMB)				
	5.2	5.4	5.6	5.8	6
Bulk Density(gm/cc)	2.45	2.48	2.49	2.51	2.48
VMA	17.37	16.40	16.01	16.42	16.89
VFB	71.28	79.47	84.01	85.62	85.81
Stability(KN)	12.51	13.75	14.95	13.35	11.88
Flow(mm)	3.02	3.48	3.95	4.81	5.48
Air Voids(%)	4.99	3.36	2.58	2.36	2.39

Table-5.5: Grading-2; Binder- virgin VG30; Mix type- Normal

Properties	% Bitumen Binder				
	5.4	5.6	5.8	6	6.2
Bulk Density(gm/cc)	2.46	2.48	2.48	2.48	2.48
Air Void (%)	3.81	2.79	2.40	2.25	2.12
VMA	17.02	16.58	16.69	17.01	17.35
VFB	70.57	71.15	74.61	77.75	80.76
Stability(KN)	14.32	15.01	13.95	12.01	9.89
Flow(mm)	3.6	3.71	3.82	4.19	5.83

Table-5.6: Grading-2;Binder-Crumb Rubber Modified VG30 with 5% crumb rubber, Mix type Modified

Properties	% Bitumen Binder				
	5.4	5.6	5.8	6.0	6.2
Bulk Density(gm/cc)	2.44	2.48	2.60	2.38	2.25
Air Void (%)	4.93	3.30	2.60	2.38	2.25
VMA	17.23	16.79	16.63	16.88	17.21
VFB	72.23	73.34	75.35	78.89	81.18
Stability(KN)	13.79	15.32	16.92	15.98	14.34
Flow(mm)	3.62	3.78	3.95	4.22	5.27

Table-5.7: Grading-2;Binder Crumb Rubber Modified VG30 with 10% rubber, Mix type Modified

Properties	% Bitumen Binder				
	5.4	5.6	5.8	6.0	6.2
Bulk Density(gm/cc)	2.46	2.48	2.50	2.5101	2.505
Air Voids(%)	4.15	2.98	1.95	1.56	1.43
VMA	17.08	16.52	16.07	16.18	16.51
VFB	72.69	73.82	76.83	79.12	81.02
Stability(KN)	15.73	17.13	18.51	16.73	14.98
Flow(mm)	3.42	3.54	3.80	4.11	5.08

Table-5.8: Grading-2 Binder-Crumb Rubber Modified VG30 with15%crumb rubber, Mix type Modified

Properties	% Bitumen Binder				
	5.4	5.6	5.8	6.0	6.2
Bulk Density(gm/cc)	2.45	2.48	2.49	2.49	2.48
Air Voids(%)	4.53	3.30	2.27	2.05	2.09
VMA	17.42	16.79	16.35	16.60	17.07
VFB	70.94	72.32	74.06	77.62	80.73
Stability(KN)	13.29	15.33	16.28	15.83	14.28
Flow(mm)	3.35	3.60	3.83	4.20	4.76

VI. CONCLUSION

From this study it is concluded that the mixture of optimum crumb rubber with conventional bitumen improves its properties. At higher temperatures (i.e 40^0c-60^0c) the modified bitumen mix performed satisfactorily. When we use the waste crumb rubber in the mix the percentage of optimum bitumen also reduces. The maximum stability for both the gradings is attained when 10% crumb rubber is mixed with conventional bitumen and after the optimum bitumen mix if further addition of crumb rubber is done the stability begin to decrease. This study also suggests a way to dispose waste rubber and does not cause any harm to the environment. All the parameters of marshall mix design and the gradation of bituminous concrete follow the specifications given by MORT&H.

VII. REFERENCES

[1] Indian Road Congress (IRC) (2010) "Rubber modified bitumen in road construction".

[2] MORTH. (Ministry Of Road Transportation and Highway).

[3] "Crumb rubber modifier" by Michal Heltzman.

[4] Rokade S. "Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements,"

[5] Indian Roads Congress IRC: 37-2012 - Guidelines for the design of flexible pavementsAugust 2012.

[6] Sundaram & Roja, (2008) "The use of recycled material in highway construction".

[7] G. Senthil Kumaran, NurdinMushule and M.Lakshmipathy: "A Review on Construction Technologies that Enables Environmental Protection: Rubberized Concrete", American J. of Engineering and Applied Sciences 1 (1): 40-44, 2008 ISSN 1941-7020, 2008 Science Publications.

[8] Hak-Seo Kim, Andras Geigerccc 6th ICPT, Sapporo, Japan,"Effects of Asphalt Ratios on Properties of Crumb Rubber Modified Asphalts", July 2008.

[9] IRC-37-(Flexible pavements design) Mannual.

[10] Johnny Bolden, Taher Abu-Lebdeh and Ellie Fini "Utilization of Recycled and Waste Materials in Various Construction Applications" American Journal of Environmental Science, 9 (1): 14-24, 2013

[11] Khanna S K, Justo C E G and Veeraragavan A. "Highway Material and Pavement Testing (Laboratory Manual)", Nemchand and Bros, Roorkee 2000.

[12] Ministry of Road Transport and Highways. "Specifications for road and bridge works" Fourth Revision, Published by Indian Road Congress on behalf of the Government of India, 2001.

[13] Niraj kumar Gupta, Prof. Dhananjay Yadhav "Use of Waste Tire Rubber in A Partial Replacement of Aggregate in Concrete",IJARIIE, Vol-2 Issue-1 2016, ISSN(O)-2395-4396

[14] Naveen Sheoran& Ravi Kumar "Experimental Study on Waste Rubber as A Partial Replacement Of Course Aggregates in Concrete, IRJET, 4(11), 2017.

[15] Sheoran. "Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements", International Journal of Engineering Researches and Management Studies, 4(8) August, 2017. ISSN: 2394-7659 IMPACT FACTOR- 2.789

[16] Nabin Rana Magar "A Study on the Performance of Crumb Rubber Modified Bitumen by Varying the Sizes of Crumb Rubber" International Journal of Engineering Trends and Technology (IJETT) – Volume 14 Number 2 – Aug 2014 ISSN: 2231-5381 http://www.ijettjournal.org

[17] R.K.Kolisetty, H.S.Chore "Utilization of Waste Materials in Construction Activities: A Green Concept" Department of Civil Engineering D.M.College of Engineering Sector-3, Airoli, Navi Mumbai-400708 (India)