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# Effect of Crumb Rubber on the Properties of Bituminous Mix

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**ABSTRACT:** A bituminous paving mix is a mixture of coarse aggregates and bitumen mixed in suitable proportion to result strong and durable mix to withstand traffic load. An experimental study is carried out to explore the use of crumbled rubber, a waste product which is obtained from waste vehicle tyres. The main purpose of this project is to study the effect of crumbled rubber on the properties of bituminous mix. Marshall stability test is conducted to determine the properties like stability, flexibility, etc. For with adding crumbled rubber to VG 30 and without adding crumbled rubber to the optimum bitumen content results are compared. The experimental work is carried out by using specifications from MoRTH(Ministry of Road Transport and Highway). It is observed that VG 30 with crumbled rubber satisfied desired criteria specified by a much higher margin. Hence , it has been recommended to utilize crumbled rubber where ever available, not only reducing the cost of execution, but also partly solve the crumbled rubber disposal problems.

KEYWORDS: CRMB, Marshal stability.

## I. INTRODUCTION

Construction of highway involves huge outlay of investment. A precise engineering design may save considerable investment; as well as reliable performance of the in-service highway can be achieved. Two things are of major considerations in this regard- pavement design and mix design. A good design of bituminous mix is expected to result in a mix which is adequately strong, durable and resistive to fatigue and permanent deformation and at the same time environment friendly and economical. A mix designer tries to achieve these requirements through a number of tests on the mix with varied proportions of material combinations and finalizes the best one. This often involves a balance between mutually conflicting parameters. Bitumen mix design is a delicate balancing act among the proportions of various aggregate sizes and bitumen content. For a given aggregate gradation, the optimum bitumen content is estimated by satisfying a number of mix design parameters.

#### **CRUMB RUBBER USED IN MAKING MIX**

Crumbled rubber is the term usually applied to recycled rubber from automotive and truck scrap tyres. During the recycling process steel and fluff is removed leaving tire rubber with a granular consistency. Continuous process with a granulator or cracker mill, possibly with the aid of cryogenics or mechanical means, reduces the size of the particles. Studies have revealed that waste rubber have great potential for use in rubber modifies bitumen road as its addition in small doses about 5-10% by weight of aggregate helps in substantial improving the marshal stability strength, fatigue life and other desirable properties of bituminous mix leading to improved longevity and pavement performance. The use of waste rubber thus contributes in construction of green road.



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## ADVANTAGES OF USING CRUMB RUBBER MODIFIED BITUMEN:

- Higher resistance to deformation under increased road temperature improves smoothness to drive.
- Improved adhesion property and bonding nature with aggregates, higher softening point.
- High skid resistance.
- Higher elongation and tensile strength, increases elasticity.
- Reduces degree of rutting, improves driving comforts even on higher axle loads.
- High resistance to moisture or water absorption hence there is no damage to roads during rain and improper drainage.

#### PAVEMENT

The pavement may be defined as relatively stable layer or crust constructed over the natural soil. It helped make them durable and able to withstand traffic and the environment. They have a life span of 20 to 30 years. The main function of the pavement is to support and distribute the heavy wheel loads of vehicles over a wide area of the underlying sub-grade soil and permitting the deformation within elastic or allowable range and provide an adequate surface.

#### BITUMEN

Bitumen is a black and highly viscous liquid or semi-solid form of petroleum .It may be found in natural deposits or may be a refined product; it is a substance classed as a pitch. Until the 20<sup>th</sup> century, the term asphalt was also used. The word is derived from the Ancient Greek. The primary use (70%) of bitumen/asphalt is in road construction, where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete. Its other main uses are of bituminous waterproofing products, including production of roofing felt and for sealing flat roofs.

## **II. MATERIALS AND METHODOLOGY**

#### MATERIALS USED

- Bitumen
- Crumb rubber
- > Aggregates

## METHODOLOGY

The various stages are presented below:

- Collection of materials such as Bitumen (VG30), Aggregate , fine aggregate , filler , Crumb rubber.
- > Test on aggregate such as Abrasion test, Impact test, Water absorption test.
- ➢ Test on bitumen.
- > Mixing of crumb rubber and bitumen to check the properties of crumb rubber modified bitumen.
- Mixing of crumb rubber, Aggregate, Filler and Bitumen by dry process.
- Test on Crumb rubber modified bitumen to check stability of bituminous mix of various size of crumb rubber by marshal stability test.



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## **III.LABORATORY TEST RESULTS**

## MARSHALL TEST RESULTS ON PAVING MIX WITHOUT ADDING CRUMB RUBBER

Bitumen Content (%)	Theoretical specific gravity (Gt)	Bulk specific gravity (Gm)	Air voids Vv (%)	Volume of bitumen Vb (%)	VFB (%)	VMA (%)	Stabili- ty value (kg)	Flow value (mm)
5.0	2.42	2.38	1.65	11.16	87.11	12.81	1328	2.3
5.0	2.43	2.37	2.10	11.01	83.98	13.11	1327	2.2
5.0	2.41	2.39	1.23	10.80	90.56	13.03	1328	2.4
5.5	2.41	2.31	4.13	12.38	74.89	16.53	1760	2.45
5.5	2.42	2.32	4.15	12.59	75.29	16.31	1759	2.3
5.5	2.39	2.32	4.12	12.58	79.37	15.68	1761	2.5
6.0	2.41	2.33	3.73	13.68	78.57	17.41	1536	2.5
6.0	2.37	2.32	2.48	13.79	84.75	16.27	1537	2.6
6.0	2.39	2.32	2.58	13.79	84.33	16.71	1536	2.7
Bitumen content(%)		5		5.5			6	
Average stability(kg)		1327.6		1760			1536.3	
Avg flow value(mm)		2.3		2.41			2.6	



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## MARSHALL TEST RESULTS ON PAVING MIX WITH ADDING CRUMB RUBBER(6%,8%,10%)

Bitume-	Theoreti-	Bu	lk	Air	Volume	VFB	VMA	Stabili-	Flow	
n	cal specific	spec	ific	voids	of	(%)	(%)	ty value	value	
Content	gravity	grav	ity	Vv	bitumen			(kg)	( <b>mm</b> )	
(%)	(Gt)	(Gr	n)	(%)	Vb (%)					
5.0	2.42	2.3	4	3.30	10.37	75.86	13.69	1759	2.8	
5.0	2.41	2.3	3	3.20	10.39	75.89	13.67	1757	2.7	
5.0	2.43	2.3	5	3.40	10.38	75.87	13.68	1758	2.6	
5.5	2.39	2.3	2	3.74	11.32	75.22	15.05	2165.3	2.7	
5.5	2.41	2.3	1	3.70	11.34	75.24	15.07	2165.4	2.8	
5.5	2.42	2.3	3	3.75	11.35	75.25	15.08	2165.5	2.9	
6.0	2.36	2.2	9	4.59	12.11	72.5	16.72	1867	3.03	
6.0	2.39	2.2	26	4.61	12.15	72.51	16.74	1867.4	3.07	
6.0	2.38	2.2	7	4.58	12.13	72.49	16.73	1867.3	3.06	
Bitumen content (%)			5			:	5.5		6	
Average stability (kg)			1758			2165.4		1867.23		
Avg flow value (mm)			2.7			2.8		3.05		



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## IV. EXPERIMENTAL RESULTS

Figures shows the results of optimum content and stability of crumb rubber without adding crumb rubber





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#### **V. CONCLUSION**

- 1. All the values obtained from the physical test on aggregate (impact test, crushing test, water absorption test) are within the limits by the MoRT&H requirements.
- 2. The values obtained from the physical test on bitumen (penetration test, softening point test, ductility test) are within the limits specified by IRC SP:53-2002 and IS: 73-2000.
- 3. By studying the results of the conventional bitumen and the crumb rubber modified bitumen, it is concluded that the penetration value and the softening value of the conventional bitumen can be improved significantly by modifying it with the addition of the crumb rubber which is a major environmental pollutant.
- 4. The utilization of crumb rubber in paving mix, reduces the amount of bitumen content needed for required performance and for these results. Crumb rubber improve the aging resistance their by increasing the longevity of pavement infrastructure.
- 5. From the obtained result, the Marshall stability value corresponding to the optimum bitumen content 5.5% is 2165 kg for paving mix with replacement of crumb rubber. Stability value corresponding to optimum bitumen content at 5.5% is 1760 kg for paving mix without adding crumb rubber. It is concluded that optimum bitumen content strength will be more in paving mix with crumb rubber, hence there will be reduction in bitumen cost which leads to economy.

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