

# BEHAVIOURAL STUDY ON BITUMEN MIXED WITH CRUMB RUBBER, QUARRY SCREENINGS AND USING EMULSIFIERS IN FLEXIBLE PAVEMENT

JEEVAN .C<sup>1</sup>, P.HARIHARAN<sup>2</sup>, S.MOHAMMED JAVID HAZEEM<sup>3</sup>, K.ABDUL KAFOOR<sup>4</sup>, S.MANJU<sup>5</sup>

<sup>1</sup>UG STUDENT DEPT OF CIVIL ENGINEERING, K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY, TRICHY, TAMILNADU, INDIA

<sup>2</sup>UG STUDENT, DEPT OF CIVIL ENGINEERING, K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY, TRICHY, TAMILNADU, INDIA

<sup>3</sup>UG STUDENT, DEPT OF CIVIL ENGINEERING, K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY, TRICHY, TAMILNADU, INDIA

<sup>4</sup>UG STUDENT, DEPT OF CIVIL ENGINEERING, K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY, TRICHY, TAMILNADU, INDIA

<sup>5</sup>PROFESSOR, DEPT OF CIVIL ENGINEERING, K.RAMAKRISHNAN COLLEGE OF TECHNOLOGY, TRICHY, TAMILNADU, INDIA

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**ABSTRACT-** The aim of a project is to utilize the scrap materials eg- crumb rubber (tyre powder form) and quarry screenings which were obtained from quarries were used as a layer in pavements waste from waste tyre scrap yards are used in highway flexible pavements in a safety manner from an environment .

First section of this study refers that the crumb rubber waste is crushed and powdered form by performing basic tests such as penetration test, ductility test, softening point test, viscosity test and softening point tests are determined. on the basis of the conductive performances of bitumen modified, the Marshall values , Marshall stability value, Marshall flow values , air voids, voids in aggregate and voids in bitumen and quarry dust were determined from Marshall stability test, CBR tests for subgrade is also determined serves the result values to assess the quality of flexible pavement. The design and analysis of bituminous materials mainly depends upon the quality assurance and percentage of binders, quarry screenings were used as a additional binders in flexible pavements, experimental results were undertaken to check the pavement strengths and durability of these mixes.

**Keywords –CRUSHED AND POWDERED, CONDUCTIVE, QUALITY ASSURANCE**

## I. INTRODUCTION

At present scenario disposal of rubber wastes produced from lorries and from different industries is a great problem. This lead to environmental pollution and health hazards for animals and plants in the atmosphere and imposes threat to environment. Most of the construction materials used for roads are soil subgrade, stone aggregates, sand, bitumen, and emulsifiers etc. Also, cost of extraction of good quality materials is increasing. To overcome this situation, it is recommended to use alternative sustainable materials that are used for highway construction, by which the pollution and disposal problems may be substantially reduced. The need for these waste in India, were formulated and usage of disposable tyres from scrap yards, so the scraped tyres can be minimized and protect threat from environment. Although by adding crumb rubber, the modified bitumen shows different properties from that of ordinary roads. So quarry screenings and emulsifiers were used to lock the pavement materials in flexible pavements and shows better properties from normal modified bitumen.

### 1.1 General

Definition: crumb rubber is recycled rubber produced from automobiles and truck scraped tires. During the recycling process of these rubber crumb , steel and tire cord are removed with the presence of fire melting properties and tire rubber are produced with powdered form.

#### 1. Binder Alterations

Binder properties may be improved by using different stages and materials. Binder modification has been driven by the increase in the traffic loads, ESWL, refining technologies, enhanced polymer technologies, the increasing need to

recycle the waste material such as WASTE TYRES, rubber materials like vehicle tubes, rubber pipes etc.

## 2. Purpose of bitumen Alterations

- To obtain softer materials at low temperature for reducing cracks.
- To increase the stability and strength of mixes
- To improve cohesive strength in pavements
- To improve the oxidation and resist ageing
- To reduce cost of pavement
- To increase strength against rutting, fatigue and cryogenic cracks and reduces damasks and thermal sensitivity

### A. Use of crumb rubber and quarry screenings in highway flexible pavements

In India waste scrapped tyres are termed as solid waste or hazardous waste. It is used to modify bitumen in appropriate manner. So that it's resistance to temperature and water results better .thus CRMB modified road shows better properties. Quarry screenings which are powdered and extracted from rock stones or from quarries .The raw dust in flexible pavement helps to improve the lock between aggregates and bitumen and holds with up to maximum strength. Thus reduces cracks, widening of roads, and failure of roads possess minimum. It provides smooth runs in a pavements. It can be also used in projects like expressways, 4 lane single, double carriageway etc.

### B. Sources of generation of crumb rubber

Crumb rubber is manufactured from primary feed stocks: tyre buffing (powdered rubber) a by product of fire retreading and scrap tire rubbers. On average 4 to 5Kgs of crumb rubber can be produced from one passage tyre in a retreading plants. Nowadays tyre retreaders in our country is being rarely extracted.

### C. Materials

In this study, the materials used are

- i. Bitumen
- ii. Quarry screenings
- ii. Crumb rubber
- iii. Aggregates.

## II. LABORATORY INVESTIGATIONS

### 2.1 Aggregates (Fine & coarse)-

Aggregates plays a vital major role in a highway pavement structure. It is obtained from Rock stones extracted from suitable plants and obtained as a varying sizes. The varying size differs due to mechanical interlocking of subgrade, bitumen and additional binders. Which possess higher strengths and durability in pavements. The function of aggregates in flexible pavements is that the voids in a coarse aggregates are filled by a fine aggregates.

**Table 1.**laboratory investigations results

Test on aggregate	Coarse aggregate
Fineness modulus	20.45
Shape test elongation	68.16
Shape test flakiness	10.15
Specific gravity	2.85
Water absorption	2
Aggregate impact value	3.64
Aggregate crushing value	8.33
Los - angles abrasion	13.82

## 2.2 Primary Tests-

Bitumen and crumb rubber is being mixed thoroughly, Before mixing the Crumb Rubber waste with bitumen in buckets, bitumen would have to be heated up to about 400 Deg C first. To achieve this, pans of bitumen were heated for 15 to 20 mins in a outdoor experiment. After that, Crumb Rubber in percentage of 5%, 10%, 15%, 20% was added into the pans and were mixed manually by using trowel about 5 minutes or until its melted state is obtained. At this time a crumb rubber of varying procedures were added while heating. Aggregates were also added and stirred for some time and till its dense state is obtained. Later the samples of mixes were tested in laboratory experiments like ,viscosity tests ,penetration tests, softening point tests ,specific gravity tests were determined.

## 2.3 Sample Preparation (Marshall Stability test)

The sample preparation was done as per the following procedure.

- a) Required quantities of coarse aggregate, fine aggregate and aggregates were taken in a separate buckets.
- b) The quantities of CRMB, quarry screenings and emulsifiers were taken separately.
- c) The bitumen is heated up to 400 Deg C before mixing of CRMB in to it.
- d) The amounts of varying percentage of crumb rubber(5,10,15,20%) were added in a separate containers and in bitumen and heated up to reach its level
- e) The aggregates were sieved on 13.6 mm micron sieve and prior to mixing it with the bitumen.
- f) The CR (crumb rubber) waste is being added to the aggregate and was mixed for 2minutes.
- g) Now, the required quantity of first trial percentage of bitumen (say, 5 % by weight of mineral aggregates) is added and until the dense mixture and uniform colour consistency obtained.
- h) The mixture is thoroughly mixed with hand trowel so the voids gets filled with the presence of heating temperature. The fine bitumen milk should be obtained until it is thoroughly mixed.
- i) Then the mix was transferred to a casting mould.
- j) This mix was then compacted by the Marshall Hammer.75 No. of blows were given on each side of the sample so that total of 150 No. of blows was given
- k) The sample were kept dry for 24 hrs
- l) After 24 hours it is demoulded and, Marshall Stability tests were determined.

## 2.4 Bitumen test-

In order to determine different properties of Crumb rubber, the various laboratory experiments were determined. Such as, penetration test, ductility test, softening point, viscosity tests. The Difference in properties can be followed as in following table

**TABLE 2 .bitumen tests penetration and ductility test**

Sample	Penetration value (1/10 <sup>th</sup> of mm)	Ductility value (mm)
Bitumen	75	750
PB+5%CR	51	350
PB+10%CR	79.4	298.5
PB+15%CR	108	240
PB+20%CR	110	187
Result value	84%	36.65%

**TABLE 3.bitumen tests softening pont and viscosity**

Sample	Softening point (°C)		Viscosity (mins) at 60°C
Bitumen	41	41	3
PB+5%CR	59.6	60.58	4
PB+10%CR	71.5	78.5	5.5
PB+15%CR	90	109	6.02
PB+20%CR	110.5	119	6.8
Result value	357.7		19.88



**Fig 1** Marshall stability Samples



**Fig 2** Closer View of Marshall Sample



**Fig 3** Marshall Samples in Thermostatically Controlled Water Bath



Fig 4 Marshall stability test

### III. TEST RESULTS

The studies of Different properties of the crumb rubber waste mixed bitumen shows that the addition of crumb rubber waste to bitumen increases softening point, increases penetration value and decrease ductility value and viscosity tests. Moreover, it also increases Marshall Stability range value. From these observations the Optimum Bitumen Content is 5.5.

TABLE 4. Results of Bituminous Mix Vg 30 grade

Bitumen content percentage	Marshall stability value	Flow value	Bulk density	Air voids	V.M.A percentage	V.F.B Percentage
	S Kg	F mm	G <sub>M</sub> Gm	V <sub>v</sub> percentage		
5	710.23	3.15	2.545	3.987	16.32	78.32
10	822.32	3.54	2.3452	3.654	16.869	79.32
15	992.32	4.56	2.295	3.2345	17.345	81.99

TABLE 5. Results of bituminous Mix for Varying percentage of CR

CR %	Bitumen Content Percentage	Marshall Stability Value	Flow Value	Bulk density o	Air voids	V.M.A percentage	V.F.B percent
		S Kg	F mm	G <sub>m</sub> gm / cc	V <sub>v</sub> Percent		
5	5.0	1045.8	3.16	2.32	3.60	11.64	65.5
10	5.0	1102.6	2.56	2.32	3.60	11.47	67.2
20	5.0	1178.5	2.47	2.32	3.60	11.22	70.3

### IV . CONCLUSION

From laboratory works, an alternative use of crumb rubber is under study where crumb rubber is mixed with bitumen and used for preparing the mix. The mix was used to study the basic properties of bitumen like penetration value, ductility value and softening point, viscosity value. The crumb rubber blended with bitumen is subjected to different tests as discussed before. Here VG 30 penetration grade bitumen was taken and it was modified with different percentage of crumb rubber in small pieces of 3 to 5 mm starting from 10% - 20%. From the results, the maximum percentage of crumb rubber as bitumen modifier was in the range 10 - 15% by the weight of binder contents.

Softening Point, Viscosity test, were found to be increased by 19.64 %, 63.5%, 11.94% and 13.51% respectively, by the addition of 12% crumb rubber waste.

Overall, using the crumb rubber in bituminous mixture helps to

- I. Reduction in the use of bitumen
- ii. To utilize the waste
- iii. Increases in the strength and performance of the road.
- iv. Provide better adhesion between the bitumen, quarry screenings and the aggregate.
- v. It avoids the use of chemical agents, binders in pavements.
- vi. It provides less cost and it is a economic in nature
- vii. Avoid disposal of crumb rubber waste by incineration or dumping by means of landfills
- viii. It possess eco friendly and economic in nature
- ix. The properties and durability will possess good strengths
- x. Develop a technology, Green technology

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