ISSN: 2456 - 1819
EIJO: Journal of Civil Engineering, Architecture, Interior Design and Innovative Research (EIJO–CEAIDIR)
Einstein International Journal Organization (EIJO)
Available Online at: www.eijo.in
Volume – 3, Issue – 1, January – February 2018, Page No. 13 - 18

# Experimental study of using Crumb rubber in bituminous road

Mohammad Junaid Rather[1], Suhaib Firdous[2]
M.Tech Scholar in GEC, Panipat
Assistant Professor in Civil Engineering, GEC, Panipat

**Abstract:** Crumb Rubber Modified Bitumen (CRMB) is hydrocarbon binder obtained through physical and chemical interaction of crumb rubber (produced by recycling of used tyres) with bitumen and some specific additives. Crumb rubber or waste tyre rubber, is a blend of synthetic rubber natural rubber, carbon black, antioxidants, fillers, and extender type of oils which are soluble in hot paving grade. Asphalt rubber is obtained by the incorporation of crumb rubber from ground tyres in asphalt binder at certain conditions of time and temperature using either dry process or wet processes (method of modifying the asphalt binder with CRM from scrap tires before the binder is added to form the asphalt concrete mixture). There are two different methods in the use of tyre rubber in asphalt binders; first one is by dissolving crumb rubber in the asphalt as binder modifier. Second one is by substituting a portion of fine aggregates with ground rubber that does not completely react with bitumen. The Flexural range of CRMB offers binders which are stable and easy to handle with enhanced performances. CRMB is suitable for pavements submitted to all sorts of weather conditions, highways, traffic denser roads, junctions, heavy duty and high traffic sea port roads etc. In this paper, the properties of CRMB by varying the percentage Bitumen mix was added varying from 2.5 to 5% at an increment of 0.5 %. Also the fillers, Crumb rubber were mixed as per design and the hazards of waste tyres are discussed..

**Keywords:** Waste Tyre Rubber, Bitumen, Crumb Rubber, Flexible Pavement.

## 1.0 Introduction

In the construction of flexible pavements, bitumen plays the role of binding the aggregate together by coating over the aggregate. It also helps to improve the strength of the road. But its resistance towards water is poor. Anti-stripping agents are being used. Bitumen is a sticky, black and highly viscous liquid or semi-solid which can be found in some natural deposits or obtained as by-product of fractional distillation of crude petroleum. It is the heaviest fraction of crude oil, the one with highest boiling point (525°C) .Various Grades of Bitumen used for pavement purpose:30/40, 60/70 and 80/100. The desirable properties of bitumen for pavement are:

- Excellent binding property with aggregates, both cohesive and adhesive in nature.
- Thermoplastic in nature (stiff when cold , liquid when hot)

Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. Traditionally soil, stone aggregate, sand, bitumen, cement etc. are used for road construction. Natural material being exhaustible in nature, its quantity is declining gradually. Also, cost of extracting good quality of natural material is increasing. Concerned about this, the scientists are looking for alternative materials for highway construction, by which the pollution and disposal problems may be partly reduced. Keeping in mind the need for bulk use of these solid wastes in India, it was thought expedient to test these materials and to develop specifications to enhance the use of waste tyres in road making in which

higher economic returns may be possible. The possible use of these materials should be developed for construction of low volume roads in different parts of our country. The necessary specifications should be formulated and attempts are to be made to maximize the use of solid wastes in different layers of the road pavement.

**1.1 Hazards of Tyre Waste**

Unrecycled tire waste is an enormous global problem because of their non-biodegradability, their flammability and their chemical composition that leads to leaching of toxic substances into the ground on dumping and hazardous fumes on incineration. Since they are hefty, thick, and made of multiple materials, scrap tires present distinct challenges in recycling and disposal. The disposals of tires in landfills have proven to have negative effects on the environment. Not only do they take up a great deal of space within a landfill, but their process of decomposing has created a wide variety of issues that have made their disposal in landfills unfeasible and in many regions, banned. The process of bubbling of trapped methane gas has been linked to increased mosquito and other insect breeding, contamination of both underground and above ground water systems, as well as chemically destroying many beneficial bacteria that grow in the soil within and surrounding a landfill. Tires have been stock piled for years both legally and illegally. In the United States alone there are about two billion around the country, with an estimated 279 million to be added to this number in the next few years. The legal stockpiling of tires increases the risk of fires which can burn for months on end, creating further pollution in the air and ground, while the illegal disposal of tires in forests, water ways and empty lots have caused pollution which cannot be regulated. The most obvious hazard associated with the uncontrolled disposal and accumulation of large amounts of tires outdoors is the potential for large fires which are extremely detrimental to the environment.

1) Tires are designed and built to last and as such be not naturally degradable and difficult to treat. This poses a huge problem in recycling them.
2) Accidental fires caused in stock piled sites can rage for months releasing toxic fumes. The oily residue left after tire fire is difficult to eliminate from the environment.
3) Waste tyre use for industrial applications by burning emits Green House Gases and thereby contributes to global warming and climate change.
4) These waste tyres are produced carbon by burning process.
5) This amount of tyres is very large manner so it becomes dangerous as well as uncomfortable to placing, because of Land problems to our country.
6) Equally hazardous are tyre fires, which pollute the air with large quantities of carbon smoke, hydrocarbons, and residue.
7) Not only are this tyre mounds eyesores, they are also environmental and health hazards. The little pools of water retained by whole waste tyres create an ideal breeding ground for mosquitoes.
8) These fires are virtually impossible to extinguish once started

**1.2 Crumb Rubber**

Crumb rubber is a term usually applied to recycled rubber from automotive and truck scrap tires. During the recycling process steel and fluff is removed leaving tire rubber with a granular consistency. Continued processing with a granulator

and/or cracker mill, possibly with the aid of cryogenics or mechanical means, reduces the size of the particles further. The particles are sized and classified based on various criteria including color (black only or black and white).

**Figure 1: Crumb Rubber**

### 1.3 Advantage of Rubberized Bitumen Over Plain Bitumen

Following are the various advantages of Rubberized bitumen over plain bitumen:

- Rubberized bitumen has higher softening point, giving more stability to the pavement during hot months.
- Improves resistance to cracking, resulting in stronger and more durable overlays for corridors in the areas of extreme climatic conditions and heavy traffic loads
- Reduces deformation on road at elevated temperature
- achieves more viscosity and elastic recovery as compared to conventional bitumen
- Better adhesive property
- Higher stability and flexibility.
- Much improved Elastic Recovery over 60, giving resistance to fatigue.
- Improved resistance to stripping due to water repellent properties.
- Lower susceptibility to daily and seasonal temperature variation.
- Better age resistance properties.
- Much improved Elastic Modulus increases load carrying capacity.

## 2.0 Marshall Stability Test

The Marshall Stability and flow test provides the performance prediction measure for the Marshall Mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute. This test procedure is used in designing and evaluating DBM mixes and is extensively used in routine test

programmed for the paving jobs. Thus, it can be concluded from the study that the modifiers when used in 4 % by weight of bitumen can improve the stability of pavements, best among them being PET bottles.

**SMA Methodology**

For this research work aggregate, bitumen (60/70) and crumb of scrap tyre was used. Different properties of bitumen and aggregate have been tested. Then prepare different mixes of bitumen and crumb of waste tire rubber with varying proportions by using wet process.

**Specimen Preparation**

**(1) Number of Specimen:** At least three specimens are prepared for each combination of aggregates and bitumen content.

**(2)Preparation of aggregate**: Aggregates are dried to temperature at 1050C – 1100C and separation by dry sieving into desired size fractions.

**(3) Sieve analysis of aggregates:** Numbers of trials are done to fix the proportion of different aggregate by sieve analysis. This portion is very important in bitumen mix design.

**(4) Preparation of mixing and compaction temperature**: Bitumen is heated to about 1350C to 1450C so that the water vapor present in it is evaporated & aggregates are heated to about 170°C-175°C. Bitumen is mixed thoroughly with aggregates by manually or mechanically.

**(5) Preparation of mould and hammer:** Specimen mould and compaction hammer are cleaned thoroughly and mould assembly is heated in hot air oven to a temperature of about 1500C. A little grease is applied to the mould before the mix is placed in the mould.

**(6) Preparation of Specimen**: The amount of each size of fraction required to produce a mixed aggregate of 1200 gm. As per gradation is weighted, the required height of specimen is 63.5±1 mm. aggregate and bitumen is heated separately to the require temperatures. Then bitumen is poured in aggregate as per requirement. Then mixture is mixed till a uniform coating of bitumen is obtained on aggregate. This is obtained at about 1500C.

**(7) Compaction of the Specimen**: Mould is assembled and a little grease is applied to it. Mix is transferred into 3 layers and each layer being tamped with spatula by 25 times. Then 75 blows are applied through manually or electrically operated compactor. Then same numbers of blows are applied on the other side of mould. Then the specimen is allowed to cool, once the specimen comes to room temperature de-mould is carried out.

**(8) Application of water bath**: Before testing mould on Marshall Apparatus, the moulds are followed to keep in the water bath for 30 to 40 minutes at 600C. Mould should be tested within 3 to 4 minutes after taken out from water bath.

**(9) Basic parameters of Marshall Test**: Mould is put out on Marshall Apparatus and Marshall Stability as well as Marshall Flow is measured by proving ring and flow dial gauge respectively. The minimum value of proving ring is 1 division = 0.01 mm and flow dial gauge 1 division = 0.25 mm. the correction factor is depends on capacity of Marshall Apparatus.

The values of Unit weight, Stability, Vv, VMA and VFB are shown in Table 1


**Fig 2: Marshall Stability Apparatus**

**Table 4.3: Marshall Properties of Specimens with Filler Crumb Rubber**

| **Bitumen Content (%)** | **Unit Weight (kg/m$^3$)** | **Stability (KN)** | **Flow Value (mm)** | **Air Void VA (%)** | **VMA %** | **VMB %** |
|---|---|---|---|---|---|---|
| 2.5 | 2375 | 15.49 | 3.12 | 7.2 | 21.3 | 42.3 |
| 3 | 2388 | 15.58 | 3.41 | 6.5 | 19.7 | 52.8 |
| 3.5 | 2412 | 15.76 | 3.51 | 5.8 | 18.2 | 58.9 |
| 4 | 2448 | 16.20 | 3.68 | 5.1 | 17.4 | 63.8 |
| 4.5 | 2402 | 15.69 | 3.62 | 4.8 | 16.3 | 72.8 |
| 5.0 | 2325 | 15.19 | 3.57 | 4.2 | 15.4 | 81.2 |

**Conclusion**

**1.** By using the recycled rubber powder, there can be improving in the properties of asphalt used in road and also cleans not only help the environment but also to the final price of asphalt producer.

**2.** The Optimum percentage of Crumb Rubber is found to be 4 % to the weight of the Bitumen.

**3.** The biggest advantage of using rubberized bitumen is that the road life increases in comparison to the normal bitumen whereas the cost increases on the road.

**4.** Addition of waste tyres as rubber aggregate modifies the flexibility of surface layer.

**5.** Problem like thermal cracking and permanent deformation are reducing in hot temperature region.

**6.** Rubber has property of absorbing sound, which also help in reducing the sound pollution of heavy traffic roads.

**7.** Waste rubber tyres thus can be put to use and it ultimately improves the quality and performance of road.

**8.** Conventional stone aggregate can be saved to a certain quantity.

**References**

**1.** D. RAGHAVAN, H. HUYNH & C.F.FERRARIS. "Workability, mechanical properties, and chemical stability of a recycled tyre rubber-filled cementitious composite," Journal of Materials Science, pp1745-1752, Vol.33, Year 1998.

**2.** Shivnaath Mehra, Abhishek Mittal, P.N. Sharma, "Laboratory Study on CRMB Modified Bitumen Mixes with Titan Polymer", Journal of Civil Engineering and Environmental Technology, Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 1, Number 2; August, 2014 pp. 90-9.

**3.** Foad Ali Zolfaghari, Farzad Zolfaghar, Mohammad javid, "Modification of Bitumen by Varying Percentage of the Crumb Rubber in Coarse Graded Aggregates", International Journal of Scientific Engineering and Technology Research Volume.03, IssueNo.19, September-2014, Pages: 4002-4010

**4.** Harpalsinh Raol, Abhijeet singh Parmar, Dhaval Patel, Jitendra Jayswal, "effect of the use of crumb rubber in conventional bitumen on the Marshall stability value", International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308

**5.** S. Shankar and C.S.R.K. Prasad, "Evaluation of Rutting Potential for Crumb Rubber Modified Bitumen in Asphaltic Mixes," Emirates Journal for Engineering Research, pp.91-95, 14(2), 2009.

**6.** Mahrez A. Properties of rubberized bitumen binder and its effect on the bituminous mix [M.S. thesis] Kuala Lumpur, Malaysia: Faculty of Engineering, University of Malaya; 1999.

**7.** Isacssofl, IJ, and Lu, X., Laboratory Investigation of Polymer Modified Bitumen, Proceedings of Association of Asphalt Paving Technologists, vol. 68, (1999) pp. 35.

**8.** Jain, P.K., Sangita, Bose, S. and Arya, I.R., Characterization of Polymer Modified Asphalt Binders for Roads and Airfields, ASTM STP 1108 (1192), pp, 341-355.