

## **A REVIEW ON EXPERIMENTAL STUDY OF CRUMB RUBBER MODIFIED BITUMEN ON PROPERTIES OF SEMI-DENSE BITUMINOUS CONCRETE MIX**

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**Abstract—** In India the actual characterization of crumb rubber modified bitumen binders has over all remained the only means of expecting their performance in pavement coats short of constructing pavement test sections and improved characterization is proved by various tests done on crumb rubber. In present world environment pollution has become an alarming issue due to the over use of resources and minerals, in light of environment pollution waste tire disposal is a serious problem so an attempt can be made to prevent this problem by using the waste rubber in the technical field and also reduces the environmental pollution and cost of pavement. Since 1870 crumb rubber is obtained from shredding of scrap tires and several studies had suggested to use 15%-20% of crumb rubber for modification of plain bitumen and got improved results like better-quality fatigue and permanent deformation characteristics. Adding crumb rubber also reduces the temperature susceptibility and greater resistance to moisture damage compared to normal mixes. In this study the main focus is to observe the performance of crumb and also to include stone dust as filler in the modified bitumen and thereby improve the performance of semi dense bituminous concrete.

**Keywords—** Crumb rubber, Marshall Test, Rutting resistances, Skid resistance, ITS

### **Introduction**

Crumb rubber is a recycled material obtained from different things example vehicle tires and other forms of machines that use rubber. The rubber is then collected and is shredded into different sizes as per the requirement. Usually the sizes are available from microns to mm. throughout the recycling course the steel and tire cord fluff are detached. The crumb rubber is considered as the best binder in the pavement materials since 1840. Every year millions of tires are discarded across the Asia. So, to decompose the waste tires is a big issue and it leads to environmental pollution. The normal or traditional methods that are used to decompose the waste tires are like stockpiling or illegal dumping or land filling are of which are short term solution. To save the environment we need to utilize and decompose non-biodegradable material i.e. rubber in a good way so that there will be no effect on the environment like we can use this in the technical field for many purposes. It is observed that using crumb rubber can reduce reflective cracking, rutting and increase the temperature susceptibility. Moreover, the cost of construction is less as it is easily available in the market all over the Asia. Adding to this, according to past studies we can mix crumb rubber with bitumen up to 15% to 20% to get the optimum bitumen content.

### **1.1 Methods of Producing the Crumb**

#### **1) Ambient mechanical grinding**

In ambient mechanical cracking, shredding of the waste tires continues at or beyond normal room temperature. Ambient grinding is a mutli-step technology and usages the vehicle tires in the system of strip or chips. The rubber, wire mesh, fabrics are continuously separated out. Tires passed through a shredder which cut them into chips. The chips are further cut into smaller pieces, but the wire mesh is removed during the process and finer particles can also be obtained by further grinding.

Most of the production of crumb rubber is obtained from ambient grinding and then obtain both fine and coarse crumb rubber from this process and the machines that are used for adequate grinding are

- Secondary granulators
- High speed rotary mills
- Screw press

#### **2) Cryogenic grinding**

In cryogenics grinding the waste tires are grinded at a temperature near -80°C by using the nitrogen or commercial refrigerants. Cryogenic processing usually practices pretreated vehicle tires.

This process takes places at very low temperature to brittle the rubber. It consists of four parts such as primary size reduction, cooling, separation and milling. The rubber go into the freezing portion where the liquid nitrogen is used to cooling it from - 80 to 120°C below this point the rubber ceases to act as soft material and can be simply grinded.

Due to its solid state, wire meshes, and other metals and fibers are separated out in a hammer chamber. This waste

passes through a number of magnetic screens and changing stations removes the last vestiges of impurities. This method requires less power to produce the crumb rubber and it helps to obtain finer material.

### **1.2 Crumb Rubber Modified Bitumen (CRMB)**

In crumb rubber modified bitumen, bitumen is replaced with crumb rubber by its weight. It has been seen from previous researches that we can use crumb rubber up to 15% to 20% by its weight of bitumen to get the optimum bitumen content. Because the increasing amount of waste rubber is a serious issue to decompose it. There are so many methods to decompose the discarded tires, but they all are short period methods because the waste rubber is a non-biodegradable material, so it is better to use it in the technical field and it is a life time decompositions method and it has been seen that by using the crumb rubber in bitumen has shown a great change on the properties like penetration, ductility, softening point, flash point and fire point and so many like rutting value, refractive cracking, fatigue stress and has reduced the cost in pavement constructions.

There are two methods in CRMB

- a) Dry process
- b) Wet process

In **Dry process** aggregates get replaced with crumb rubber by its weight i.e. both coarse and fine aggregates. The crumb rubber is added while keeping the aggregates in an oven at a temperature of 210°C for almost 1hr, then the aggregates are removed from the oven and crumb rubber is added in that by its weight and the temperature during the mixing should be at least 140°C and the CRMB should be mixed uniformly.

It has been found that by adding more quantity of crumb rubber viscosity of the modified asphalt binder increases at pumping and mixing temperatures.

Since 1960s **Wet process** method has been used in pavement materials and has shown us the great change on the properties and has reduced the cost of constructions. This method is easier than dry process, takes less time and requires less man power.

In today's world, the waste production is greatest obstacle to tackle. The production of waste material boosted up since industrial revolution. The wastes are produced from every field from plastic waste to construction waste. The rate of production of new products cause immense pressure on resources and become hub of pollution to environment. Maximum researches were conducted to increase the use of waste materials so that pressure on virgin resources can be minimized.

## **1. OBJECTIVES OF THE STUDY**

The aim of the study is the Experimental Study of Crumb Rubber Modified Bitumen on Properties of Semi-Dense Bituminous Concrete Mix. The main objectives of this study are as follows:-

- a. To study the different properties of crumb rubber modified bitumen by Marshall Stability test.
- b. To check the permanent deformation and fatigue life of CRMB.
- c. To compare the rutting strength, ITS and skid resistance of CRMB and the normal mix.

## **2. LITERATURE REVIEW**

### **Studies on Crumb Rubber**

**Kumar A. et al. (2017) [1]** studied the Experimental study of crumb rubber in semi dense bituminous concrete. They have added the crumb rubber in bitumen with different percentages (3%, 6%, 9%, and 12%) and have found the mechanical properties of bitumen grade 60/70 at a temperature of 110°C-120°C and further they have calculated the optimum bitumen content of the normal mix of Marshall Samples. The crumb rubber had used as addition with the Marshall samples So, as to find the Marshall properties, the results clearly shows us that after adding the crumb rubber with the bitumen has shown a better improvement on stability like it increased up to 12.84KN ,Bulk density also increased and also show changes on other properties as well.

**Anand G. et al. (2017) [2]** determines the performance of semi-dense bituminous concrete (SDBC) by adding the polymer fibers. This study examines to attempt the behavior of SDBC when selected waste material such as polyester, polypropylene, was used individually with bitumen of grade 60/70. They have performed the Marshall samples on normal mix where they found the OBC and then modified the Marshall samples with polyester, polypropylene individually and calculated the stability and other properties also. The Marshall stability of Polyester and Polypropylene has increased the it 15.41KN and 14.18KN as compared to normal mix i.e. 13.74KN. The higher stability values indicate as modified mix would have less suscepibility to cracking of flexible pavements.

**Akther M. et al. (2017) [3]** The Research is about The Laboratory Evaluation of SDBC, DBC, OGPC Mixes. She worked on the three different layers of bituminous concrete, where she performed the many tests including the Marshall Test and had found optimum bitumen content for each layer i.e. 5.2% for DBC and 4.95% for SDBC and 4% for OGPC, Furthermore she had performed the ITS and DTS for each layer. The results clearly shows us that the stability, Indirect tensile strength, Uniaxial compression strength is increasing as we move from OGPC to DBC due the enough amount Air voids and no filler in it.

**Nema M. et al. (2013) [4]** studied the use of china clay waste in semi dense bituminous concrete. In this research their main aim was to decompose the industrial waste on the roads so as to reduce the environmental effect , further more they have replaced china clay sand as fine aggregate on SDBM and also made the comparison using the stone dust as replacement with china clay. They performed the Marshal Stability test where they found its properties which showed there is improvement on the stability, flow values, bulk density etc. by using the china clay sand as compared to stone dust and have suggested to use it in rural areas because of low traffic volume.

**Yu X. et al. (2013) [5]** this research is about the effect of kinds and pleased of warm mix additives with crumb rubber modified. In this they worked on the WMA additives can adequately minimized the construction temperature of crumb rubber modified asphalt mixture without seriously impact on the engineering properties. In this they have made crumb rubber modified asphalt by adding the asphalt binder with crumb rubber fine particles of dimension 40mesh and 18% by weight of asphalt, numerous benefit rates of two different warm mix asphalt additives, sasobit and Isotherm were added to the CRMA. They have performed tested like high temperature behavior, Temperature sensitivity and fatigue resistance. These tests indicate that the types and content of warm mix asphalt additives have good impact on all the properties of CRMA.

**Xie Z. et al. (2013) [6]** the research is about the long term performance of SMA mixture with crumb rubber by dry process. In this long term performance of 3 years in service testing pavement of stone matrix asphalt with crumb rubber is mixed by using the dry process and numerous tests were done on that and from results it clearly shows us a good change on dis-stresses of cracking. Rutting ,Reveling, bleeding, pushing, and potholes ,were not found in rubberized PEM wearing layer under which rubberized SMA and polymer modified asphalt the bio-modified rubber. Their core aim of this research is to relate the Rheological properties of bio modified rubber with crumb rubber modified bitumen used in USA, now from the results it has been seen bio-binder of crumb rubber modified concrete was used.

**Fini E. et al. (2012) [7]** In this study they worked on the bio-modified rubber in which the bio binder was made from swine manure by using the thermo-chemical process. the bio-binder were blended with crumb rubber and asphalt binder to produce reduces the asphalt viscosity and compaction temperature.

**Yadav o. et al. (2012) [8]** the study is about the cold mix design of SDBC. In this present study their main aim is to conserve and protect the environment by using the bitumen emulsion on SDBC-2. They employed dry and wet process with & without addition of filler 2% that is cement and hydrated lime. They have conducted the tests like Indirect Tensile Strength (ITS) and Marshal test by using both processes using 2% filler. The result tells us that there is an improvement on properties as compared to normal mix where as the optimum was taken as 6 days of curing.

**Mohammad L. et al. (2011) [9]** the research is about to study the characterization of hot mix asphalt mixture containing high reclaimed asphalt payment content with crumb rubber additives and in this their main objective was to use the crumb rubber from waste tires and engineering additives as a rejuvenator of high reclaimed asphalt payment content asphalt mixture. In this they have prepared 6 asphalt mixtures by mixing aggregates with 4asphalt binders. The Rap content was varied from 0-40% and crumb rubber was added in both the ways (Dry & wet mix), Hot mix asphalt includes tests like moisture resistance, resistance to cracking, rutting using flow number tests, the degenerate creep strain energy test, semi-circular bending test and the effects clearly shows that by mixing Rap and crumb rubber were having adequate moisture resistance, superior rutting as compared to the standard mixtures (fracture and cracking resistance were reduced).

**Bressette T. et al. (2007) [10]** the research is about asphalt rubber and its potential use in China and in this the main objective was to reduce the crumb rubber in China as it was getting increased by 12% every year and they have worked on asphalt rubber technology and its uses in China and they have found the good changes in that as compared to normal grade. They have shown that asphalt rubber mix have multiple advantages like durability, reflection cracking, oxidation due to higher binder content, resistance to surface initiated fatigue and anti-oxidant in the tire rubber, the research is all about the change in the asphalt rubber technologies and discuss many asphalt rubber items used by California departments of transportation and their potential use in china

### 3. CONCLUSIONS

In present study, numerous past works were fully studied and following conclusions were drawn on the basis if same:

1. From the experimental study it can be drafted clearly, that there is a clear improvement in the mechanical properties of the blended mix. The crumb rubber modified bitumen has resulted in the decrease in the penetration and the ductility values, as compared to that of the normal bitumen of viscous grade VG-30. The results also reveal that the softening point of the normal bituminous blend has also increased a little.
2. The optimum bitumen content of normal bitumen as compared to Modified bitumen has reduced from 5.2% to 4.8%, The Marshall stability is increasing in case of modified mix as compared to normal mix i.e. from 1430kg to 1495kg, whereas the flow value and Air voids are decreasing as compared normal mix .From the Skid resistance test we got to know that the skid number of modified bitumen has increased by 20% as compared to normal bitumen.
3. The indirect Tensile strength is increasing due to addition of crumb rubber because the rubber has the property of binding the aggregates therefore it has reduced the fatigue failures on the pavement roads.
4. The Rutting test is generally performed to reduce the permanent deformation on the roads which is the main concern, therefore by adding the crumb rubber on bitumen has shown a great improvement on the pavement roads, because the rubber is elastic in nature and has property to regain its shape after applying the external force on it.

5. Therefore at last I came to conclusion that the introduction of the crumb rubber in the SDMB was definitely a good alternative. By this introduction, the properties of the SDMB ha entirely improved, and made a great impact on some of the properties like ITS, Rutting and Marshal Stability. With all these properties, the inherent properties of the SDBM were also put at a glance, by improving the skid resistance, stripping values of the mix, and at last it was revealed that up to 12% of crumb rubber is perfect for the addition of SDBM.

### 5. ACKNOWLEDGEMENT

This review was supported by Dr. Arpita Saha, Assistant Professor, Department of Civil Engineering, Lovely Professional University, Punjab, India. So, I express my sincere gratitude to Dr. Arpita Saha Assistant Professor (Department of Transportation engineering) and supervisor of the project to avail us facilities and best guidance during my work. It's an honor to express thankfulness to her for her keen interest in helping me and correcting my mistakes and making me aware about various processes and mechanisms of construction works and also being very friendly and encouraging by allowing me to work under their respectable department. This helped me a lot and allowed me to work hard in during execution of this project. I shall always be very grateful to her for having great faith in me.

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