

Influence of Crumb Rubber Modified Bituminous Mix on Asphalt Pavement

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Abstract: In today's world one of the serious problem of pollution that leads to environmental harm is the increase of waste tires of vehicle as the demand of vehicles is increasing. Use of waste tires in Road Construction can resolve these issue. With the purpose of solving these issue and increasing the engineering properties of the Road pavement these study of use of Crumb Rubber in Road Construction was done and is presented here. The study focuses on effect of Crumb Rubber on Bituminous Asphalt by partially replacing aggregates with Crumb Rubber in 5%, 10%, 15% respectively by the weight of it using Marshall Stability Test Apparatus and Various Laboratory tests on Aggregates which are Impact Value test, Crushing Value test, Los Angeles Abrasion test. It was found that addition of Crumb Rubber in Bituminous mix fulfilled the Marshall Mix Design Criteria. Properties of Impact and Crushing increases significantly whereas results of Los Angeles Abrasion value decreased. The study showed that Crumb Rubber can be added upto 10% by the weight of aggregates where 5% shows good Marshall Stability Value when performed on Marshall Stability Test Apparatus. Also the study focuses on promoting recycle of waste tires and maintaining eco-friendly environment.

Keywords — *Crumb Rubber, Eco-friendly, pollution, Marshall Stability, Mix Design, Waste Tires.*

I. INTRODUCTION

1.1. General:

Today, disposal of different type of waste is a major threat to us and for the upcoming generation as it is creating pollution to a great level. There is need to find alternative method to recycle these types of wastes as there is no proper method of disposing it. Waste tires is one of these material and is causing major problem. Due to the increase in the population there has been tremendous increase in vehicles which is leading to the problem of waste tires. Alternative method must be found to resolve these issue. Use of these type of material can be done in road construction by properly recycling it. Road Construction mainly involving aggregates and Bitumen which are naturally occurring materials are also declining. So alternative for these material is a need for an hour. Waste tires recycled in Crumb Rubber can be used a partial replacement of Aggregates.

1.2. Crumb Rubber:

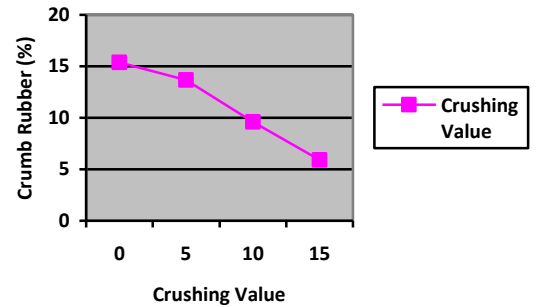
It is the type of material which is obtained from truck and automotive scrap tires. During recycling process the steel and tyre cord are removed from the tires leaving behind the tyre with granular consistency.



Fig 1. Crumb Rubber

1.3. Benefits of using Crumb Rubber

- a) Rubber is a noise reducing agent hence use of it in Road construction reduces noise pollution
- b) Presence of rubber prevents moisture absorption which reduces the pothole formation in roads.
- c) Reduction in thermal cracking which avoids crack formation.
- d) Provides good road grip, which reduces accident rate.
- e) Large area used for dumping rubber can be utilized beneficially



1.4. Objective of study

- a) The main objective of the study is to utilize the waste rubber in Road Construction
- b) To Observe the effect of Crumb Rubber in Road asphalt by partially replacing aggregates by the weight of it in Various proportions.
- c) To perform Marshall Stability Test on Various blend to find a sustainable and stable pavement mix.

Crushing Value Test is used to determine the Aggregate crushing value as per IS:2386(Part 4)-1963. It provides the relative measure of resistance to crushing under gradually applied load. Less the crushing value greater will be the resistance to crushing under gradually applied compressive load.

Aggregate crushing value for cement concrete pavement shall not exceed 30%. While for wearing surfaces it is 45%.

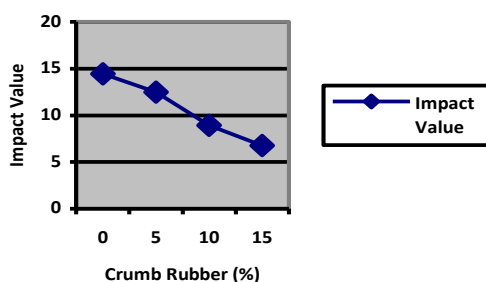
II. RESULT AND DISCUSSION

Various tests were performed on Aggregates and Crumb Rubber partially replaced aggregates.

- 1. Impact Value Test
- 2. Crushing Value Test
- 3. Los Angeles Abrasion Test

Results Obtained when above mentioned tests were performed are as follow:

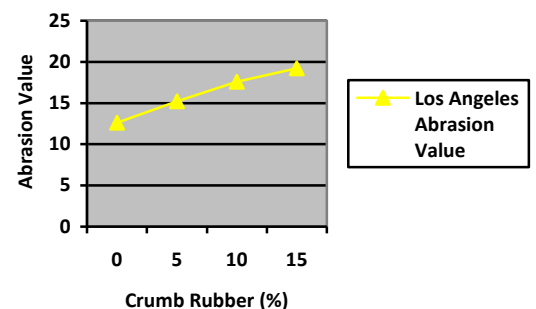
1. Impact Value Test



Aggregate Impact Value Test indicates impact value of aggregates as per IS:2386(Part 4)-1963. It indicates the relative measure of resistance of an aggregate to sudden shock or impact. Lower the value greater the resistance to sudden shock or impact. Aggregate value more than 35% is considered bad for road construction.

2. Crushing Value Test.

3. Los Angeles Abrasion Test.



Los Angeles Abrasion Value indicates the abrasion value of aggregates as per IS:2386(Part 4)-1963. Hardness is the property of aggregates used in Road Construction. Los Angeles combines the process of abrasion and attrition. Abrasion is the factor that causes rupture.

Above mentioned tests shows that the impact and crushing property of aggregate increases with partial replacement of Crumb Rubber as they wouldn't break into pieces as its absorb the load coming on it whereas Los Angeles Abrasion Test result decreases.

III. MARSHALL STABILITY TEST

a. General:

For finding the stability and flow value of the blend, Marshall Stability Test is performed which measures the maximum load sustained

by the bituminous material at 50.8mm/min. It is defined as the maximum load carried by the specimen at a standard test temperature of 60°C. Flow value refers to the vertical deformation when maximum load is reached. .

b. Marshall Sample Preparation.

A Proper mix of 1200gm consisting of all the coarse aggregate, fine aggregate and filler material is taken in a pan and heated upto 175°C to 190°C. The Bitumen is heated upto its melting point prior to mixing. The amount of crumb rubber required is weighed and kept separately. The aggregates are taken out and then heated on gas for several minutes to maintain the desired temperature. The Crumb Rubber is added to it and mixed for several minutes .Afterwards the required quantity of bitumen is added and mixed properly until a uniform mix color is obtained. Then the mix is transferred to the casting mould and then it is compacted by the Marshall hammer. 75 blows are given from both the sides each. Then the samples along with mould are kept for 24 hours.

After 24 hours the sample is removed from the mould, it is weighed in air and water and kept in water bath having 60°C for 30 to 40 minutes. The sample is removed afterwards and then Marshall Stability And Flow Value is checked on Marshall Stability Test Apparatus.



Fig 2. Aggregates, Filler material and crumb rubber

Marshall Compactions are used to prepare Marshall samples with compactors. It consists of base plate, mould body and a collar. Sample Prepared must be between 61mm to 65mm in diameter.

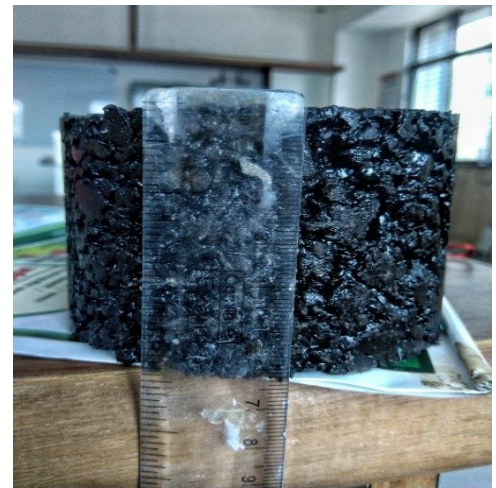
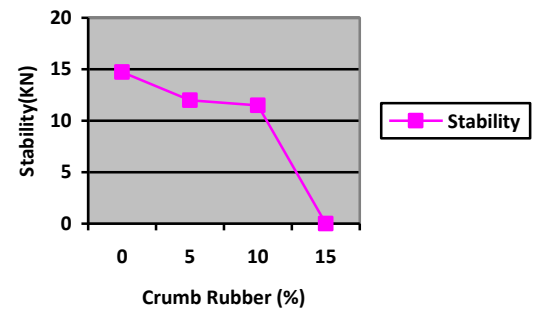


Fig 3. Sample preped (63mm)

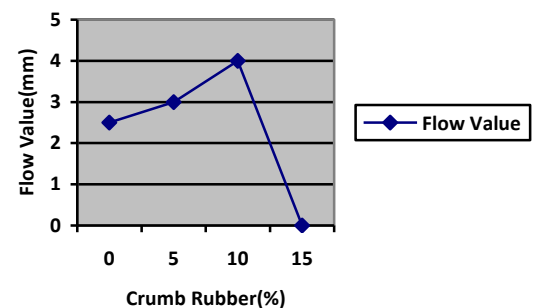
c. Marshall Stability and Flow Results:

Sr no.	Bitumen	Crumb rubber	Stability (KN)	Flow value(mm)
1	4.5%	0	14.71	2.53
2	4.5%	5%	12	3
3	4.5%	10%	11.5	4
4	4.5%	15%	-	-

Graphical representation of Stability with constant bitumen percentage (4.5%):



Graphical Representation of Flow Value with constant bitumen percentage (4.5%)



The above results states that Marshall Stability when Crumb Rubber is partially by aggregate fulfills the Marshall Mix Criteria. When 5% Crumb Rubber is mixed in asphalt mix it shows good stability and flow value as compared to others.

Marshall Mix of 15% is not possible as binding of the mix was not possible when Marshall Stability Test was performed. Properties of the mix increased when crumb rubber is added to the mix . As Crumb Rubber is a noise reducing agent noise pollution can be eliminated to some extend .

Crumb Rubber prevents the moisture absorption which does not allow water to percolate hence formation of potholes is reduced. The property of impact and crushing value of the aggregates increased significantly when partially replaced by Crumb Rubber which results in long life of the road and its load carrying capacity increases.

Increase of utilization of crumb rubber in Road Construction can solve the problem of dumping of it hence a vast land would be available for beneficial use. By using Crumb Rubber a sustainable road pavement is obtained which is more durable and its maintenance cost would be minimized.

IV. CONCLUSION

Based upon the various experimental test results and observation the following conclusions are drawn:

1. Crumb Rubber can be used as a partial replacement of aggregate.
2. Crumb Rubber can be used upto 10% as a partial replacement of aggregate by the weight of it.
3. Formation of potholes can be reduced by using Crumb Rubber.
4. Noise pollution can be controlled.
5. The Aggregate Impact and Crushing properties increases significantly by addition of crumb Rubber hence resulting in increase in life of the load and load carrying capacity.
6. Problem of Decomposing of Crumb Rubber would be solved.
7. Area required for decomposing of Crumb Rubber can be used beneficially.
8. A sustainable and ecofriendly pavement can be achieved.
9. As the natural resources are also declining, use of crumb Rubber as partial replacement of aggregate is a great alternative.

ACKNOWLEDGMENT

We are greatly thankful for all the authors mentioned in the reference section for their research work as they were very beneficial and useful for these study. We would like to thank all the staff members, Lab Assistant, Civil

Engineering Department, MITSOE, MIT ADT University, Pune. Mentioned above all were very useful and we grateful for their support and constant support.

REFERENCES

- [1] Jong R. Kim, "Characteristics of Crumb Rubber Modified CRM Asphalt Concrete" KSCCE Journal of Civil Engineering, Vol 5, 2/June 2001.
- [2] Tao Ma, Yao Zhang, Xiaoming Hung, "Using RAP Material in High Modulus Asphalt Mixture" Journal of Testing and Evaluation. March 2016.
- [3] Nuha Salim Mashaan , Mohamed Rehan Karim, "Waste tyre rubber in asphalt pavement modification" Article in Material Research Innovations. April 2014.
- [4] Sharma Pavan Kumar, Saxena Anil Kumar, Arora .T.R "Experimental Study of Flexible Pavement by Using Waste Rubber Tyres " International Journal of Engineering Research and Technology ISSN:2278-0181 Vol.2 Issue 8, August-2013
- [5] IRC: SP: 53-2002. "Guidelines on use of polymer and rubber modified bitumen in road construction ", Indian Roads Congress, New Delhi
- [6] Naha S. Mahaan et. al," An overview of crumb rubber modified bitumen", International journal of the physical science, vol.7 (2), 9 january2012, pp.166-170.
- [7] B. Adhikari, D. De and S. Maiti: 'Reclamation and recycling of waste rubber', Prog. Polym. Sci., 2000, 25, 909-948.
- [8] C. Thodesen, K. Shatanawi and S. Amerkhanian: 'Effect of crumb rubber characteristics on crumb rubber modified (CRM) binder viscosity', Construction Building Materials, vol.23. no.1,295-303,2009.
- [9] H. U. Bahia and R. Davies: 'Effect of crumb rubber modifiers (CRM) on performance-related properties of asphalt binders', J. Assoc. Asphalt Paving Technologists, 1994, 63, 414-449.
- [10]. S. K. Palit, R. K. Sudhakar and B. B. Pandey: 'Laboratory evaluation of crumb rubber modified asphalt mixes', J. Mater. Civil Eng., 2004, 16, (1), 45-53.