International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 03 | Mar 2021 www.irjet.net p-ISSN: 2395-0072

A REVIEW ON EFFECT OF ADDITION OF SHREDDED PLASTIC WASTE AND RAP IN DBM

Vishal Kumar[1], Ajay K Duggal[2],

[1]M.E Scholar, Department of Civil Engineering, National Institute of Technical Teachers Training and Research Chandigarh, India
[2]Associate Professor, Department of Civil Engineering, National Institute of Technical Teachers Training and Research Chandigarh, India

---

Abstract - *A good road network consists of durable pavements for the economic, social, and sustainable development of any country. India is ranked 2nd largest in terms of road network globally having 5.8 million kilometers of road. The increasing demands of materials like fresh aggregates require incorporation of innovative techniques such as reusing old aggregates that are eco-friendly and economical. In today's world, plastic is available in huge abundance and used enormously. Plastic waste and its disposal is a major threat to the environment, considered harmful and hazardous in nature resulting in pollution and global warming. The utilization of plastic waste in bituminous mixes shows better stability, binding property, lesser stripping value and more water-resistant pavements. In addition, use of Reclaimed Asphalt Pavement (RAP) material has already gained acceptability. The use of RAP helps in reduction of use of virgin aggregates, quantity of binder used and also minimize overexploitation of aggregate resources. Many researches are done on incorporation of Shredded Plastic waste and RAP material individually; however a combination has not been tried yet. In this proposal, an effort has been made to study eco-friendly and cost saving techniques of addition of plastic waste and RAP material both individually and combined in suitable proportions on Dense Bituminous Macadam and evaluate its effect on improving the strength and durability characteristics of the pavement material.*

Key Words*: *Reclaimed Asphalt Pavement (RAP), Shredded Plastic waste, Dense Bituminous Macadam.

1.INTRODUCTION

Transportation contributes to the economic, industrial, social and cultural development of any country. A good and long lasting road network requires proper planning, designing, construction and maintenance approach. In a developing country like India, roadway construction is taking place at a very high pace which require large demand of construction material that too eco-friendly and economical. Therefore there is need to improve the durability of bituminous pavements. Scientists and engineers are constantly searching on different techniques to improve the performance of asphalt pavements. Research activities are continuously carrying out in order to enhance the properties of bitumen to make advanced flexible pavements to meet the present challenges. Considerable research has been carried as to determine the suitability of plastic waste and RAP in construction of bituminous mixes. This study draws attention to the parameters which affect the performance of DBM mixes when modified with varying percentage of shredded plastic waste and RAP materials both individually and combined respectively at suitable proportions. Due to high stability, strong longevity, relatively low maintenance and better riding consistency, shredded plastic waste and RAP materials are theoretically beneficial for paving mixes. This technique has achieved broad recognition in road construction technologies and will further gain wide acceptance.

1.1 Plastic Waste

Plastic is a recyclable material which accounts for 8% of the total solid waste generated in the country annually. It is estimated that more than 26000 tonnes of plastic waste produced in India everyday, 94% is thermoplastic, or recyclable materials such as PET (polyethylene teraphthalate), and PVC (polyvinyl chloride). It is segregated, cleaned and shredded using the shredding machine (particle size 2-3 mm). The addition of waste plastic in shredded form results in thin film coating over aggregates. It can also be added to hot bituminous mix and resulting mix is known to have some improvements in mix characteristics.

This method helps in safe disposal of plastic to reduce its harmful effects on the environment. This not only strengthens the pavement but also increases its durability and escalates its stability and other properties. Use of Plastic waste results in improving the Marshall stability and resistance to water damage, as well as can contribute to relieve some of the environmental problems caused by classical plastic waste disposal means. In addition it will also be a solution to various defects in pavement viz., pot holes, corrugation, ruts etc.

1.2 Reclaimed Asphalt Pavement (RAP)

RAP is the reclaimed asphalt pavement material which is obtained during the process of pavement's resurfacing, rehabilitation or reconstruction operation. The production of RAP results in an aggregate that can be well graded and of nominal quality. RAP has increasingly been used to replace fresh materials for new and existing pavements as an eco-friendly-sustainable solution. Most of the highways and roads are generally constructed as flexible pavement and are generally designed with fresh aggregates and virgin bitumen. Apart from over exploitation of aggregate resources and environmental issues, roads need periodic overlays as maintenance action which intends to attain a higher raised level. During road reconstruction and rehabilitation, proper handling of demolished pavement becomes a great problem. The process of making RAP mix starts with the collection of RAP materials from the scarified pavement and subjected to various tests like sieve analysis, residual binder, grading etc. Use of RAP helps in conserving the natural resources, reduction in land filling and makes the project more economical.

2. NEED AND SCOPE OF STUDY

Many research studies done throughout the world have established use of shredded plastic and RAP individually in hot bituminous mixes, though the percentage addition varies. In India also some work is done on use of Shredded Plastic waste and RAP material, however a combination has not been tried. This study is a little ahead of them in a way that here it is utilizing combination of Shredded Plastic waste and RAP material in bituminous mixes. When there is addition of Shredded Plastic waste and RAP material in bituminous mixes, it helps in optimization of waste materials. It is likely to affect the performance of mix expectedly in positive manner, for which trend is to be seen.

3. OBJECTIVE

Following are the objectives of present study:

1. To study the effect of addition of both Shredded Plastic waste and RAP material combined on properties of DBM bituminous mix e.g. stability value, flow value, percentage air voids, percentage VMA and percentage VFB of DBM by Marshall Method of mix design.
2. To determine the changes in OBC resulting from addition of Plastic waste and RAP.
3. To determine the optimum ratio of blending Shredded Plastic waste and RAP material to DBM.

4. LITERATURE REVIEW

Sangita, Sharma D. K. and Sharma B. M. (2009) proposed the comparison in performance of bituminous concrete mix properties which contain plastic polymer in varying rates from 8% and 15% bitumen by weight respectively. The results indicated that waste plastic polymer has thermal stability up to 200 ^{0}C. Recycled polythene from grocery bags may be useful in bituminous pavements resulting in reduced permanent deformation in the form of rutting and reduced low-temperature cracking of pavement surfacing. They concluded that Marshall stability of modified mixes was respectively (1.21 and 1.18) times higher than conventional mixes. Coating of waste plastic over the aggregate improves the performance parameters in term of stability, flow value, flexibility and rutting.

Bindu C.S & Dr. K.S. Beena (2010) examined the behavior of Waste plastic as a stabilizing additive in Stone Mastic Asphalt. The Physical Properties of waste plastic coated aggregates were evaluated and the results are presented. Conventional (without plastic) and the stabilized SMA mixtures were subjected to performance tests including Marshall Stability, tensile strength and compressive strength tests. Triaxial tests were also conducted with varying percentage bitumen by weight of mineral aggregate (6% to 8%) and by varying percentage plastic by weight of mix (6% to 12% with an increment of 1%). Plastic content of 10% by weight of bitumen is recommended for the improvement of the performance of Stone Mastic Asphalt mixtures. It gives an increase in the stability, split tensile strength and compressive strength of about 64%, 18% and 75% respectively compared to the conventional SMA Mix and proves to be an effective stabilizing additive.

Ranadive M.S. and Honne Gowda S (2011) studied the enhancing stability of flexible pavements using plastic waste and fly ash. The use of national thermal power plant by product fly ash instead of mineral filler and waste plastic from solid waste in DBM was investigated. Marshall Properties of mix with fly ash 5% are on lowering side as compared to mix with combination 5% fly ash & 2% plastic waste. Marshall Test conducted on bituminous mix with the combination of 2% plastic & 5% fly ash have the values of stability, flow, percentage air voids, VMA & VFB within the limits of specifications given by MORTH.

Gawandea Amit, Zamarea G., Rengea V.C., Tayde Saurabh, Bharsakale G. (2012) used modified bitumen with the addition of processed plastic waste of about (5-10% by weight of bitumen) helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous concrete mix. The developed techniques to use plastic waste for construction purpose of roads and flexible pavements were reviewed. According to them use of waste plastics in the manufacture of roads and laminated roofing also help to consume large quantity of waste plastics.

Kumar M. Veerendra, Muralidhara R. & Nair Divya J. (2013) did the comparative study of wet and dry blending of plastic modified bituminous mix used in road pavements.

The optimum bitumen content determined in terms of Marshall Stability test was found to be 4.98%. The enhancement in the performance was obtained at 8% partial replacement by waste plastic in both WM & DM. In comparative study of WM & DM, DM is better option to improve the performance of road pavements in terms of its fatigue, strength, stiffness by utilization of waste plastics. Utilization of plastic waste is found to be an eco-friendly solution for waste disposal and economy in pavement construction.

Rajasekaran S., Vasudevan R., Samuvel P. (2013) have studied "Reuse of Waste Plastic coated Aggregate-Bitumen Mix Composite for Road Application-Green Method". In addition to the improvement of the quality of the road, this technology has helped to use the waste plastics obtained from domestic and industrial packing materials. The softened plastics have tendency to form a film like structure over the aggregate, when it is sprayed over the hot aggregate at 160°C. PCA - Bitumen mix showed improved binding property and less wetting property. The sample showed higher Marshall Stability value in the range of 18-20 kN and the load bearing capacity of the road is increased.

Sreedevi B.G., Salini P.N, (2013) have conducted testing on "Pavement performance studies on roads surfaced using bituminous mix with plastic coated aggregates. Laboratory studies conducted on Semi Dense Bituminous Concrete (SDBC), Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM) show that the Marshall Stability value of bituminous mixes increase by 1.5 to 2 times by using Plastic Coated Aggregates. Also bitumen consumption can be reduced by more than 10% by weight. Better strength parameters and road condition indicate increase in life of pavement and delayed and slow deterioration, improved performance in terms of better surface condition, delayed pot hole and crack initiation and progression, desirable skid resistance and surface texture.

Singh Jashanjot, Duggal A.K (2015) Studied the RAP mixes to achieve a better understanding of how high RAP affects the mixture performance properties that are important for more hard-wearing and cost-effective asphalt. This paper presented the optimization of the use of RAP in surface courses such as Bituminous Concrete. In this study various properties like Marshall Stability, Flow value and Density of bituminous mixes using RAP with varying percentage from 25 to 40% were compared to that of fresh bituminous mix. This study concluded that RAP 35% showed results similar to that of virgin bituminous mix, and the cost of project was reduced by 50%.

Athira R. Prasad, Sowmya N. J (2015) have studied the bitumen modification with waste plastic and crumb rubber. In this study comparison is carried out between use of different waste plastic like carry bag, PET bottles, crumb rubber and all three in varying rates like 3%, 4.5%, 6%, 7.5%, 9% by weight of bitumen in bitumen concrete mixes to examine the better ability to modify bitumen so as to use it for road construction. It is concluded that Optimum content was obtained at 6% in all three cases and Marshall Stability is higher in case of PET bottles as compared to rubber and polythene.

Raghvendra Jadon, Rajeev Kansal (2016) advocated the experimental study on the bituminous concrete mix and was carried out by using well-graded aggregates, Plastic shredded in size between 2mm to 8mm, the binder of VG 30 grade. It is found that the value of optimum binder content was 5.33% by weight of the aggregates for the conventional mixes. After the determination of OBC for conventional mix samples at a different percentage like 0.5%, 1%, 1.5% and 2% of waste plastic were prepared with the change in binder content at given plastic content. The optimum plastic content was found to be 1% by weight of the aggregates.

Thakur Shivani and Duggal Ajay Kumar (2017) studied on reutilization of plastic waste in paving mixes. They concluded that effect of addition of waste plastic bag and PET in paving mix shows good result on various properties of mix such as VMA, VFB, air voids and stability with 7% WPB and 6% PET, also shows 28% and 35% increase in stability in PET and WPB respectively compare to control mix i.e. DBM. According to them, the waste polythene utilized in the mix forms coating over aggregates, which reduce porosity, absorption of moisture and improves binding property.

Ahmed R.B., Rahman A., Islam K., Amin J., Palit S. K. (2018) investigated the use of RAP materials in addition of neat bitumen at various types of highway. The investigation covered the determination of bitumen content present in RAP and reclaimed aggregate gradation before Marshall Mix Design and finding out the water sensitivity of bituminous mix in terms of retained stability at OBC. The binder content present in RAP was 1.37%. From this design, the OBC was found as 4.92% and at OBC, the retained stability was found as 77.2%. Marshall Mix Design properties at OBC were in specified limit according to Marshall Mix Design criteria for a new pavement construction. So it can be concluded that reclaimed pavement materials with the addition of neat bitumen can be reused as bituminous surface course successfully.

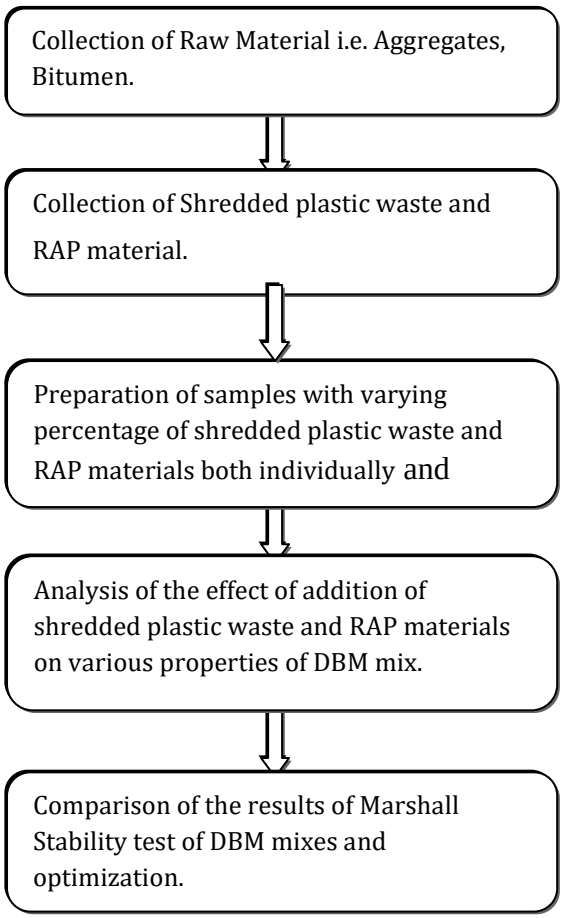
Rao Koteswara P V S, Babu Suresh P. and Kumarthe Srinivasa R. (2018) averred that the use of recycled bituminous pavement (RAP) with new aggregates and mixed with bitumen (VG-30) grade. Based on the laboratory experiments carried out in the study it was observed that mix combination of 40% of RAP with 60% of new aggregates was within the specified limits of MORTH (2013) Specifications. The engineering properties of this RAP substituted mix were found to be satisfactory and

comparable to that of the 100% virgin material in Dense Bituminous Macadam (DBM).

Guleria Shivani and Duggal A. K. (2019) studied the utilization of PET waste in Bituminous Concrete prepared with modified bitumen. In this study the addition of plastic has been done by replacing CRMB-55 by percentage by weight in varying percentage (2%, 4%, 6% and 8%). Bituminous mix namely DBM and BC were tested using Marshall Stability test. The Marshall Stability values increase with the amount of PET and maximum stability was obtained at PET 6% by weight of the binder. Considering these factors they observed that a more stable and durable mix for the pavements can be obtained by polymer modifications.

5. METHODOLOGY

In this research proposal, the chronological order of methods to perform the analysis is given:



6. CONCLUSIONS

After going through the studies carried out by different researchers, the following conclusions have been made:

1. Quality, durability and strength performance of flexible pavement construction is improved to greater extent by combining the bituminous binder with plastic waste and RAP materials.
2. Use of shredded plastic waste in bituminous mix provides slightly better results as compared to conventional bitumen.
3. Coating of plastic waste over the aggregate improves the performance parameters in term of stability, strength, flow value, flexibility, rutting resistance and reduced stripping value.
4. Addition of RAP makes the project more economical and helps in preservation of the environment as RAP materials utilization reduces use of fresh aggregates and bitumen.
5. The engineering properties of this RAP substituted mix are found to be satisfactory and comparable to that of the 100% virgin material leading to better life span of the road.
6. Recycling of RAP material and plastic waste are most efficient and environment friendly for the safe disposal of plastic to reduce its harmful effects on the environment.

REFERENCES

[1] Sangita, Sharma D. K., Sharma B. M., Sabina, Khan Tabrez A, (2009), "Performance evaluation of waste plastic/polymer modified bituminous concrete mixes", *Journal of scientific and industrial research* vol. 68, Nov 2009, pp. 975-979.

[2] Bindu C.S & Dr. K.S. Beena. (2010), "Waste Plastic As A Stabilizing Additive In Stone Mastic Asphalt" *International Journal of Engineering and Technology* Vol.2 (6), 2010, 379-387.

[3] Ranadive M.S. and Honne Gowda S. (2011**),** "The enhancing stability of flexible pavements using plastic waste and fly ash." (*Indian Highways*, Oct, 2011).

[4] Gawandea Amit, Zamarea G., Rengea V.C., Tayde Saurabh, Bharsakale G. (2012), "An Overview on Waste Plastic Utilization in Asphalting of Roads." *Journal of Engineering Research and Studies,* Vol. III/ Issue II/April -June, 2012/01-05.

[5] Kumar M. Veerendra, Muralidhara R. &Nair Divya J. (2013) "The comparative study of wet and dry blending of plastic modified bituminous mix used in road pavements." (*Indian Highways*, Dec, 2013).

[6] Rajasekaran S., Vasudevan R., Samuvel P.(2013) "Reuse Of Waste Plastic coated Aggregate-Bitumen Mix Composite For Road Application-Green Method," *American Journal of*

Engineering research 2013 e-ISSN : 2320-0847 p-ISSN : 2320 0936 Volume-02, Issue-11, pp-01-2013

[7] Sreedevi B.G., Salini P.N,(2013**)** "Pavement Performance Studies On Roads Surfaced Using Bituminous Mix With Plastic Coated Aggregates," *International Journal of Engineering Research & Technology* ISSN: 2278-0181 vol. 2 issue 9, September – 2013

[8] Singh Jashanjot, Duggal A.K (2015),"An Experimental Study on Reclaimed Asphalt Pavement in Dense Bituminous Macadam," *International Journal of Modern Trends in Engineering and Research (IJMTER)* Volume 02, Issue 08, [August– 2015].

[9] Athira R. Prasad, Dr. Sowmya N. J (2015), "Bituminous Modification with Waste Plastic and Crumb Rubber," *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)* Volume 12, Issue 3 Ver. II (May - Jun. 2015), PP 108- 115

[10] Raghvendra Jadon, Rajeev Kansal (2016), **"**Experimental Study onUse of Waste Plastic in Bituminous Concrete Mix" *International Research Journal of Engineering and Technology (IRJET)* e-ISSN: 2395 -0056 Volume: 03 Issue: 06 | June-2016

[11] Thakur Shivani and Duggal A. K. (2017), "Review on Reutilization of Plastic Waste in Paving Mixes," *International Journal for research in applied science & Engineering Technology (IJRASET)* vol. 5, pp. 1156-1159.

[12] Ahmed R.B., Rahman A., Islam K., Amin J. , Palit S. K. (2018), "Recycling of Reclaimed Bituminous Pavement Materials." *International Conference on Research and Innovation in Civil Engineering* (ICRICE 2018).

[13] Rao Koteswara P V S, Babu Suresh P. and Kumarthe Srinivasa R. (2018) "A Study on Recycled Bituminous Pavement Materials Using Bitumen Vg-30," *International Journal of Creative Research Thoughts (IJCRT)* - IJCRTNTSE080 National Conference Proceeding NTSET Feb 2018 | ISSN: 2320-2882

[14] Guleria Shivani and Duggal A. K. (2019), "Effect on addition of Plastic Waste in Bituminous Mixes prepared with CRMB," *International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)*Volume-8, pp. 2023-2028.

[15] ASTM D6927**,** Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures.

[16] Ministry of Road Transport and Highways, Specifications for Road and Bridge Works, Fifth Revision, Published by IRC New Delhi, 2013.