

Utilization of Waste Plastic in Flexible Pavement

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Abstract: Plastic waste is a common problem now a days. Plastic waste material which we can reuse by certain processing and use in road construction. Plastic is a toxic and perpetual material. Disposal of waste plastic is a menace and become a serious problem globally due to their non-biodegradable and very harmful to human health's since they are not disposed scientifically and then create a ground and water pollution. Wrappers of betel nuts, chocolate, chips, hand bags, cold drink bottles and all other forms of plastic creates significant environmental and economic problem. They consume huge energy and other natural resources, reducing the environment in various ways. Plastic cannot be banned as it will result in usage of natural resources like paper, wood at a great extent. It is made up of various chemical components and is observed as a highly pestilent material which does not certainly degrade in the natural environment after its usage. Waste plastics are prepared up of polyethylene, polystyrene and polypropylene. Temperature varying among 120°C – 160°C gives the softening point of these plastic. They do not produce any toxic gases during heating but the softened plastics have inclination to form a lamination or coating over the aggregate, when it is sprayed over the hot aggregate at 160°C. The plastics coated aggregate (PCA) is a better raw material the significance of plastic in terms of cost reduction, increase in strength and durability when these plastics are heated and coated upon the aggregates (160°C) to compensate the air voids with plastic and binds with aggregate to provide stability. PCA- Bitumen mix showed improved binding property and less moistening property. The samples showed higher Marshall stability value in the range of 18-20KN and the load bearing capacity of the road is improved by 100%. The roads laid since 2002 using PCA- Bitumen mixes are execution well. A detailed study on the performance of these roads shows that the construction with PCA- Bitumen mix are performing well. This process is eco-friendly and economical too. By this process a road of 1 Km length and 3.375M width of single lane can consumes 10,000 carry bags and the road strength is improved by 100% and there found no any pot hole. The mix polymer coated aggregate have presented higher strength. Use of this mix for road construction benefits to use plastic waste. The main objective of my project is to analyze and study how the waste plastic will be effectively utilized in construction of flexible pavement as a binder material for replacing the content of bitumen and in detail process and its successful application.

Keywords: plastic wastes, bitumen, aggregates, plastic bitumen aggregate

1. Introduction

Most of the paved roads in our country have granular sub base and base and wearing course. Plastic is a very resourceful material. Due to the industrial revolution, and its large scale production plastic seemed to be an in expensive and nominal raw material. Today, every dynamic sector of the economic starting from agriculture to packaging, automobile, electronics, electrical, building construction, and communication sector has been practically reformed by the applications of plastics. Plastic is a non-biodegradable material and researchers found that the material can sustain on earth for 4500 years without degradation. Several studies have proven the health risk caused by unsuitable dumping of plastic waste. Disposal of a selection of plastic & rubber wastes in an eco-friendly way is the drive area of today's research. Looking forward the scenario of current lifestyle a whole prohibition on the use of plastic cannot be put, although the waste plastic in roads construction is gaining importance these days because plastic roads improve better than normal ones and the plastic waste considered to a pollution hazard, can find its use. The use of waste plastic for coating the aggregate of the bituminous mix found to improve its performance characteristics. Recycled polythene carry bags were shredded into small sizes (4.75mm & 2.36mm) and is coated on aggregates of the mix at a specified temperature. Bituminous mixes were prepared with VG-30 bitumen and plastic coated aggregates/ ordinary aggregate with cement as a filler material. The use of plastic waste help in substantially improving the abrasion and slip resistance of flexible pavement and also permits to achieve values of splitting tensile strength fulfilled the specified the specific limits while plastic waste content is beyond 30% by weight of mix. This all should be occupied in awareness while mixing and laying of roads is to be done using plastic waste. The plastic road would be a benefit for India. In hot and extremely humid climate durable and eco-friendly

plastic roads are of greater advantages. This will also relief in releasing the earth from all type of plastic waste.

1.1 Why use of plastics

Polymers have number of vital properties which exploited alone all together make a significant and expanding contribution to construction needs.

- 1) Durable and corrosion resistant
- 2) Good insulation for cold, heat and sound saving energy and reducing noise pollution.
- 3) It is economical and has a longer life.
- 4) Maintenance free
- 5) Hygienic and problems
- 6) Ease of processing
- 7) Light weight

1.2 Statements of problems

The plastic waste could be used in road construction and the field tests survived the stress and proved that plastic wastes used after proper processing as an additive would enhances the life of the pavement and we can achieve road stability, minimizing cost of the bitumen. The rapid rate of urbanization and development has led to increase plastic waste production. As plastic is non-biodegradable, it remains in environment for numerous years and disposing plastic wastes at land fill are unsafe since toxic chemicals percolate out in to the earth, and under-groundwater and pollute the water bodies. Due to littering habits, insufficient waste management scheme, plastic waste disposal to be a huge problem for the civic authorities, especially in the municipal areas.

At current the disposal of waste plastic has become a major waste management problem in the world. Hence in this present investigation efforts have ready to identify the

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potential application of waste plastic in civil engineering projects. In present study the aim is to investigate the optimal use of waste plastic in bitumen for road pavement construction.

2. Literature Review

AMIT GAWANDE (2012) [1] The substantial of plastic waste in municipal solid waste (MSW) is growing owed to growing in population, urbanization, development activities and changes in life style, which leading widespread scattering on the landscape. Thus disposal of waste plastic is a menace and become a serious problem globally due to their non-biodegradability and anaesthetic view. Since these are not prepared scientifically & possibility to create ground and water pollution. This waste plastic partially exchanged the conventional material to improve desired mechanical characteristics for particular road mix. In the present paper developed methods to use plastic waste for Construction purpose of roads and flexible pavements has reviewed. In conventional road making process bitumen is used as binder. Such bitumen can be improved with waste plastic pieces and bitumen mix is made, which can be used as a top layer coat of flexible pavement. This waste plastic improved bitumen mix show better binding property, stability, density and more resistant to water.

ATHIRARPRASAD (2015) [2] The use of waste materials like plastics and rubber in road construction is being increasingly encouraged so as to reduce environmental impact. Plastics and rubbers are one of them. The plastic waste quantity in municipal solid waste is growing due to increase in population and changes in life style. Similarly most tiers, especially those fitted to motor vehicles, are manufactured from synthetic rubber. Disposal of both is a serious problem. At the same time, continuous increase in number of vehicles emphasizes on need of roads with better quality and engineering design. This waste plastic and rubber can be used to moderately replace the conventional material which is bitumen to improve desired mechanical characteristics for particular road mix. In the present study, an evaluation is carried out between use of waste plastic like PET bottles and crumb rubber (3%, 4.5%, 6%, 7.5%, 9% by weight of bitumen) in bitumen concrete mixes to analyse which has better ability to modify bitumen so as to use it for road construction.

NUHA S. MASHAAN (2012) [3] Roadways are considered one of the most important elements of infrastructure and they play an essential role in our daily lives. In road bitumen construction, the use of crumb rubber in the amendment of bitumen binder is considered as a smart solution for sustainable development by reusing waste materials. It is believed that crumb rubber modifier (CRM) could be one of the alternate polymer resources in improving bitumen binder performance properties of hot mix asphalt. This study aims to present and discuss the conclusions from some of the studies, on the use of crumb rubber in asphalt pavement.

M.S. RANADIVE ET AL.(2015) [4] An attempt has been made that the specimen of 8 percent waste polymer modified bitumen (WPMB) mix show 50 percent enhanced tensile strength compared to conventional mix and more resistance

to water damage. The tests are conducted on the bituminous specimens to know the stability, flow value, bulk density, percent air voids, and per cent V.M.A. and presented. The Maximum density of compacted specimen is observed at 5.5% bitumen content for all the proportions of plastic. And there is a sudden increase in stability when the natural aggregates are coated with plastic which is water resistant.

P.K. Jain et al.(2012) [5] They observe that the Stability, rutting and retained stability of bituminous mixes and modulus values are better and also less susceptible to moisture. Waste plastic modified bituminous surfacing are more durable and offer improved performance. The optimum quantity of plastic waste is 0.4% by weight of mixture 8% by weight of bitumen.

2.1 Case Study

Plastic is everywhere in today's lifestyle. The leading problem is what to do with the plastic waste. Use of plastic waste which is non-biodegradable is quickly increasing and investigators have found that the material can remain on earth for 4500 years unchanged and without degradation. This hazard of disposal of plastic will not solve itself and confident practical steps have to be initiated at the ground level. On the other hand the road traffic is growing with time hence there rises a need to increase the load bearing capacities of roads.

3. Research Methodology

3.1 Materials used and the tests conducted

The materials used for carrying out the present research are;

- 1) Aggregates
- 2) Bitumen
- 3) Plastic waste

3.1.1 Aggregate

Aggregate is one of the most important material used for flexible pavement construction. Properly selected and graded aggregate are mixed with bitumen to form hot mix asphalt pavements. Aggregates are the principal load supporting components of hot mix asphalt pavements. They are divided into three types according to their size: coarse aggregate that retain on 2.36mm sieve, fine aggregate are which pass through 2.36 mm sieve and retaining on 0.075mm sieve and mineral filler are the aggregate which pass through 0.075 mm sieve.



Figure 1 Aggregates

3.1.1.1 Test Conducted On Aggregate

- 1) AGGREGATE IMPACT VALUE TEST
- 2) Loss angeles abrasion test
- 3) Water absorption test
- 4) Specific gravity test
- 5) Stripping value test

3.1.2 Bitumen

Bitumen is very well known as the binders in asphalt construction (Refer Figure 2). It is one of the most important highway construction materials. The important quality of bitumen which has made bitumen a popular binding material is its excellent binding property and gets softens when heated.



Figure 2: Bitumen

3.1.2.1 Test conducted on bitumen

- 1) Penetration value test
- 2) Ductility test
- 3) Softening point test

3.1.3 Waste Plastic

The bottled water is the wildest growing beverage industry

in the world. According to the international bottled water association (IBWA), rummage sale of bottled water have increased by 500 percent over the last decade and 1.5 million tons of plastic are used to bottle water every year. Plastic bottle reutilizing has not kept pace with the dramatic increase in virgin resin polyethylene terephthalate (PET) sales and the last imperative in the ecological triad of reduce / reuse / recycle has emerged as the one that needs to be given prominence. Waste bottle plastic of water can is made up either High Density Polyethylene (HDPE) or Low Density Polyethylene (LDPE). Waste plastic bottles were crushed and shredded and then the different laboratory taste will be done. Plastic are usually classified by their chemical structure of the polymer backbone and side chain. Some important groups in these classifications are the acrylics, polyesters, silicone and halogenated plastics. Plastic are versatile packing material. Plastic is a material involving of any of a extensive range of artificial or semi-synthetic organic compounds that are flexible and can be molded into solid objects. Plastics are classically organic polymers of high molecular mass, but they often contain other substances. They are typically synthetic, most commonly derived from petrochemicals, but many are made from renewable materials such as polylactic acid from cotton linters.



Figure 3 Waste Plastics

B. Preparation of samples: four Marshall stability samples will be prepared out of which three will be with the plastic of varying percentage 5%, 10% and 15% and one sample without plastic waste

C. Performing Marshall stability test: Marshall stability test will be performed on all the samples prepared.

4. Result and discussion

4.1 Test on aggregate

Table 1 Results of tests on aggregate

Stone Aggregate	Plastic Content (%)	Aggregate Impact Value	Los Angeles Abrasion Value	Specific Gravity	Water Absorption	Stripping Value
Without Plastic	0	10.53 %	12.99 %	2.5	3.0 %	1 %
With Plastic	5	9.93 %	11.70 %	2.2	2.5 %	Nil
With Plastic	10	9.12 %	10.65 %	2.66	2 %	Nil
With Plastic	15	8.62 %	8.95 %	2.7	1.1 %	Nil

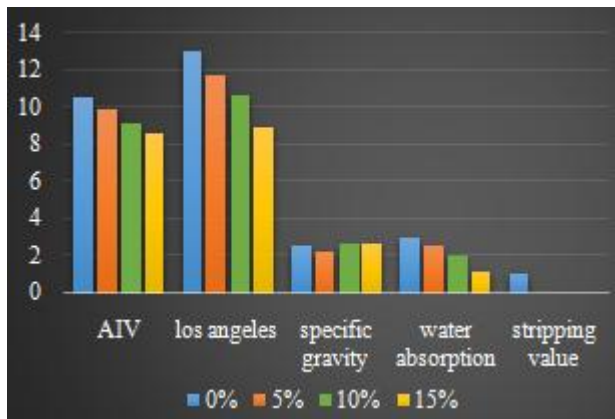


Figure 4 graph represent results of various test on aggregate

4.2 Test on Bitumen

Table 2 Results of tests on bitumen

Bitumen	Plastic Content	Softening point	Penetration Value	Ductility
100	0%	50	68	82
95	5%	53	66	69
90	10%	60	65	56
85	15%	63	64	53

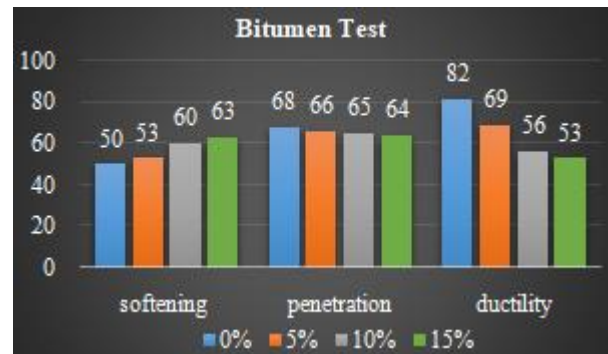


Figure 5 Graph represent results of various test on bitumen

4.3 Marshall stability test

Table 3: Marshall stability and flow value

Sample No.	Bitumen Content (%)	Plastic Content (%by weight)	Marshall Stability (kg)	Flow Value (mm)
1	4	0	950	3.6
2	3.5	5	1570	3.9
3	4.0	10	1710	4.6
4	4.5	15	1950	5

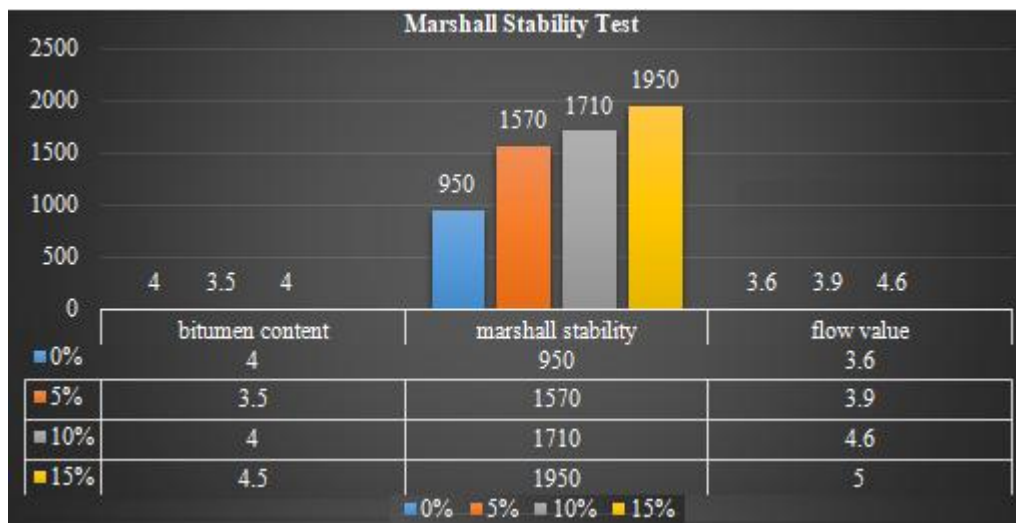


Figure 6 Graph represent Marshall stability and flow value

5. Conclusion

- 1) It shows that with the increase of waste plastic in bitumen increases the properties of aggregate and bitumen.
- 2) Use of waste plastic in flexible pavements shows good result when compared with conventional flexible pavements.
- 3) The optimum use of plastic can be done up to 10%, based on Marshal Stability test.
- 4) This has added more value in minimizing the disposal of plastic waste as an eco-friendly technique.
- 5) Coating of polymer on the surface of the aggregate has resulted in many advantages, which ultimately helps to improve the quality of flexible pavement.

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References

- [1] Amit Gawande, "Utilization Of Waste Plastic In Asphalting of Roads" Scientific Reviews and Chemical Communication: 2(2),2012,Pp147-157.
- [2] Athira R Prasad, "Bituminous Modification With Waste Plastic And Crumb Rubber", Isor Journal Of Mechanical And Civil Engineering (Isor-Jmce) Eissn: 2278-1684, P-Issn:2320 -334x Volume 12 Issue 3 Ver .Ii (May-June 2015),Pp 108-115.
- [3] Nuha S. Mashaan, "An Overview Of Crumb Rubber

- Modified Asphalt”, International journal of the physical sciences, volume 7(2), pp.166-170, 9january,2012
- [4] M.S. Ranadive Et Al.(2015),Volume-Vi,Issue-Vii,July2017
- [5] R.Vasudevan Et Al.“UTILIZATION OF WASTE POLYMERS FOR FLEXIBLE PAVEMENTAND EASY DISPOSAL OF WASTE POLYMER” International conference on sustainable solid waste management, 5-7, Chennai, India pp-105-111,2007
- [6] Saiyed Farhana Et Al.(2015)
- [7] P.K. Jain Et Al. “MITIGATION OF RUTTING IN BITUMINOUS ROADS BY USE OF WASTE POLYMERIC PACKING MATERIALS” indian journal of engineering and materials sciences , volume 18, june 2011, pp. 233-238
- [8] Mrs. Kalpana , D.Surendaran “Utilisation Of Waste Plastic In Bituminous Roads” Indian journal of pure and applied mathematics,volume-119 no.-17 2018,ISSN:1143-1156.
- [9] P.L. Naktode “Plastic Waste In Road Construction”
- [10] S.Rajasekaranetal “Reuse Of Waste Plastic Coated Aggregate-bitumen mix composite for road application – green method, American journal of engineering and research, 2, 1-13
- [11] Vetturayasudharasanan “Experimental Study On Partial Replacement Of Bitumen With Lignin And Plastic (2017)
- [12] Davide Lo Presti, “Recycled Tyre Rubber Modified Bitumens For Road Asphalt Mixtures”
- [13] Farag Khodary, Y. Mohammed, A.Wazeri “Damage Analysis Of Asphalt Concrete Mixtures Modified With Crumb Rubber/Caco3nanocomposite”
- [14] Imran M. Khan, Shahid Kabir, Majed A. Alhussain, Feras F. Almansoor, “Asphalt Design Using Recycled Plastic And Crumbrubber Waste For Sustainable Pavement Construction” (2016)