UTILIZATION OF WASTE MATERIAL IN FLEXIBLE PAVEMENT

Sudhir Yadav[1], Manish Singh Kushwaha[2], Nitin dutt sharma[3]

[1](M.Tech Scholar, Civil engineering, Greater Noida Institute of Technology, Greater Noida, UP, India)
[2](Assistant Professor, Civil Engineering, Greater Noida Institute of Technology, Greater Noida, UP, India)
[3](Assistant Engg., Civil Engineering, Greater Noida Institute of Technology, Greater Noida, UP, India)

ABSTRACT: *Waste materials not only strengthen the road but also increments road life as well as may also help to maintain environment and create a source of income. Generally disposal is done by way of land filling as well as incineration of materials which are hazardous. The better binding property of plastics in its molten state has helped in getting a method of safe disposal of plastic waste, by using them in road laying. Use of plastic waste (LDPE) as well as Crumb Rubber such as the rubber obtained from the waste tyres of vehicles, in construction of flexible pavement is gaining importance. The modifier raw material has been sourced from disposed waste plastic as well as crumb rubber. This not only allows us to collect modifier raw material at lower cost, but may also provides a solution towards ecological menace posed by increased use of plastics (nonbiodegradable). Waste materials cause environmental degradation & are toxic to human health. Waste materials increase various pavement properties such as resistance to rutting, durability, penetration resistance etc. Waste plastic, CRMB, steel slag are waste materials which are highly used in the construction of flexible pavements. A tire that can no longer serve its original intended purpose is termed as a waste tyre. A waste tire typically consists of steel (16.5%), rubber compound (70%) as well as nylon or fibre (5.5%). The use of commercial polymers like styrene butadiene styrene (SBS) as well as Styrene-Butadiene Rubber (SBR) in road and pavement construction will increase construction cost as they are highly expensive materials. However, with an use of alternative materials, such as CRMB, will definitely be environmentally essential, and not only can improve bitumen binder properties as well as durability, but it also has a potential to be cost effective. Indian consumption of plastics is 15 million tonnes (2015) and is set to be the 3 rd largest consumer of plastics in the world. Plastic wastes consisting of carry bags, cups as well as thermocoles that can be used as a coating over an aggregate which can be used for construction of road. Waste materials not only strengthen the road but also increase the life of road, help to improve environment as well as also create source of income. The strength of Semi Dense Bituminous Concrete (SDBC) has increased by about 25% by CRMB according to 2012 International Conference on Future Environment and Energy IPCBEE vol.28 (2012). Waste plastic helps in better binding of bitumen with plastic wasted coated aggregate. The polymer coating also decreases the voids, results in reducing rutting, ravelling as well as there is no pothole formation.*

Keywords - *plastic wastes, bitumen, aggregates, plastic bitumen aggregate*

1. INTRODUCTION

In a recent scenario, a world without roads, motorcycles, cars, trucks is almost unimaginable. India encompasses a road network of over 5,603,293 kilometers as on 31 March 2016.The 2nd largest road network in world. As on 31 March 2016, 62.6 %of Indian roads were paved. Only 40% of Indian roads are flexible pavements. Rest 22.5% of roads are rigid pavements. Indian roads are primarily bitumen-based macadamized roads. Because of extreme climatic conditions as well as a steady increment in high traffic intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature demands improved road characteristics. The entire road infrastructure with its diversity of transport concepts now has a prominent position in our civilization. The question is thus not so much whether or not there'll still be a road infrastructure within the future, however, rather however ca n society read these quality facilities in say20 or 30 years' time. Comparing the road infrastructure and suggests that of transport of these days with those of 40 years past, it becomes clear within the next forty years' time everything can once more look a lot different to how it looks today. Societies area unit perpetually developing and, consequently thus area unit people's requirements regarding the use, structure and design of the road infrastructure – not simply roads in urban areas (urban roads), but also the motorways (inter-urban roads) between the major cities. It is conjointly quite conceivable that the longer term construction and style of infrastructure constructions like bridges and tunnels arebe subject to completely different needs. In view of long time span of 10-15 years between planning infrastructure facilities as well as its actual completion, followed by an operational period of at least 25 years, more clarity of these future needs, demands as well as requirements becomes essential in order to make an right choices for tomorrow. Making longer term a lot of acknowledgeable and tangible reveals the gaps of information and indicates which new technologies can need to be developed to meet the future demands as well as needs. Besides generic developments such as shortage of clean environment, energy and space, spotting and extrapolating the social and economic trends and technical advances offer starting-points for forming a more realistic image of the longer term and therefore the associated desires and demands associated with road transport. Bitumen 2 is a useful binder for road construction. Different grades of bitumen like 30/40, 60/70 and 80/ 100 are

available on the basis of their penetration values. In the construction of flexible pavements, bitumen plays the role of binding the aggregate together by coating over the aggregate. It conjointly helps to boost the strength of the road. But its resistance towards water is poor. Use of plastic and rubber leads to excellent pavement life, driving comfort as well as low maintenance. Scientists and engineers are constantly searching on different methods to improve the performance of bituminous pavements. A common methodology to improve quality of bitumen is by modifying the rheological properties of bitumen by blending with organic artificial polymers like rubber as well as plastics. Polymer and crumb rubber can be used as a binder with respect to aggregate and bitumen in construction of flexible pavement. This paper aims at proposing a method of disposal of plastic and tire waste by using them on the surface course of the pavement. The Main objective of this study are safe and productive disposal of wastes - plastic and tire, study of index properties as well as suitability of waste bituminous mix on surface course of the pavement.

1.1 Objective

1) To study the physical properties of bitumen and crumb rubber, bitumen and PET, both rubber and PET mixed bitumen and at different percentage.

2) To find out an optimum percentage of waste materials in bituminous mix.

3) To improve the properties of bituminous mix and to provide the solution for disposal in a useful way.

4) To increment the Marshall Stability value

2.1 Literature Review

H. K. Sharma (2014) [1], has conducted experiment on "Utilization of Waste Plastic in Construction of Pavement" (2014). He found that Waste plastics - as binder and modifier at 130□ using Thermo gravimetric analysis there is no gas evolution in the temperature range of 130-180□. Moreover, the softened plastics have a binding property. Hence, the molten plastics materials can be used as a binder and/or they can be mixed with binder like bitumen to enhance their binding property. This may be a good modifier for the bitumen, used for road construction. The uses of plastic waste help in substantially improving the abrasion as well as slip resistance of flexible pavement and also allows to obtain values of splitting tensile strength satisfied the specified limits while plastic waste content is beyond 30% by weight of mix. If the consistent.

DR. Manju, Sathya.S, Sheema.Khas(2017) [2] been studied on "use of plastic waste bituminous pavement" (2017). This paper reveals that the utilization of waste plastic in bituminous mix enhances its properties and strength. Titanium Di-oxide is used as smoke absorbent material, which will absorb the smoke from vehicle. Addition of waste plastic in construction reduces the plastic shrinkage and drying shrinkage. Dry process is carried out for mixing process. The plastic pavements can with stand heavy traffic and are durable than flexible pavements. The stability of modified bitumen (10% bitumen replaced by plastic) is higher than the nominal bitumen. The use of plastic will reduce the bitumen content by10% increases the strength and performance of the road. The smoke absorbent material (titanium dioxide) by 10% of polymer content can reduce vehicular pollution. Thus the use of waste plastic improves the abrasion and slip resistance of bitumen pavement.

Vishal Rasal, L Nokfho K, P.M.Wale, Mrunalini Kasar, Anjali Thorat, Raunak Solanki, Ishan Dharmadikari (2018) [3], has been studied on "Experimental Study on Modified Bituminous Mix Using Waste High Density Polyethylene and Crumb Rubber" (2018). This paper presents an effort taken to produce modified bituminous mix and coated aggregates. Aggregate were coated with 6, 8, 10% of High density polyethylene (HDPE) and 8, 10, 12% of crumb rubber and were mixed with bitumen. 4 Different molds are prepared with different combination and compared with conventional bitumen mix by conducting Marshall Stability test to check its strength, flow value and stability value. The dense based macadam (DBM) mix was designed for Marshall Stability test using VG30 grade. Dry process (polymer coating of aggregates) is more useful as compared to wet process (adding polymer in the binder) for the manufacturing modified mixtures, as it can accommodate higher amount of waste plastic as modifier and results most stable mixture. Penetration values as well as softening points of plain bitumen can be improved by modifying it with addition of crumb rubber. Optimum percentage of rubber was found to be 8% and 10% of HDPE gives more satisfied results comparing to conventional bitumen. Use of waste plastic in construction of bituminous road helps to improve strength, life of road, resistance to temperature as well as water.

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 and crumb rubber

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 0.0075mm sieve and mineral filler are the aggregate which pass through 0.075 mm sieve.

Fig. 1 Aggregate

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.

Fig. 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 polylatic acid from cotton linters.

Fig. 3 waste plastic

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.

3.1.4 Crumb rubber

Use of Crumb Rubber i.e. the rubber obtained from the waste tires of vehicles in the construction of flexible pavement is gaining importance. It is also worth mentioning that, the modifier raw-material has been sourced from disposed crumb rubber. This not only allows us to collect modifier raw material at low cost, but also provides a solution towards ecological menace posed by increased use of rubber. In the present study, an attempt has been made to use Crumb Rubber, blended using wet process .Marshal method of Bituminous mix design was carried out for varying percentages of Crumb Rubber to determine the different mix design characteristics. Marshall's mix design was carried out by changing the modified bitumen content at constant optimum rubber content and subsequent tests have been performed to determine the different mix design characteristics and for conventional bitumen (VG-30). This has resulted in much improved characteristics when compared with straight run bitumen and improve the strength of pavement Modified Bitumen is one of the important construction materials for flexible pavements.

Fig. 4 Crumb rubber

4. Result and Discussion

4.1 Test on aggregate

Table 1 Results of tests on aggregate

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

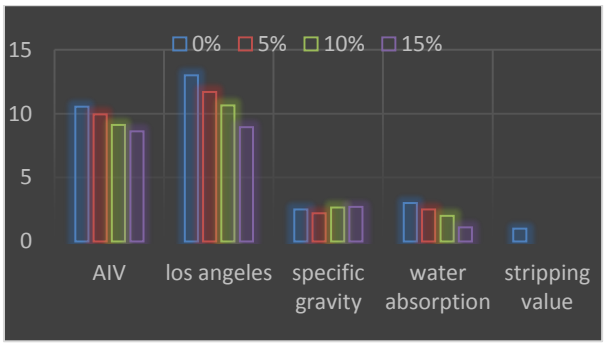

Figure 5 graph represent results of various test on aggregate

4.2 Test on bitumen

Table 2 Results of tests on bitumen

Bitumen	Plastic and crumb rubber 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

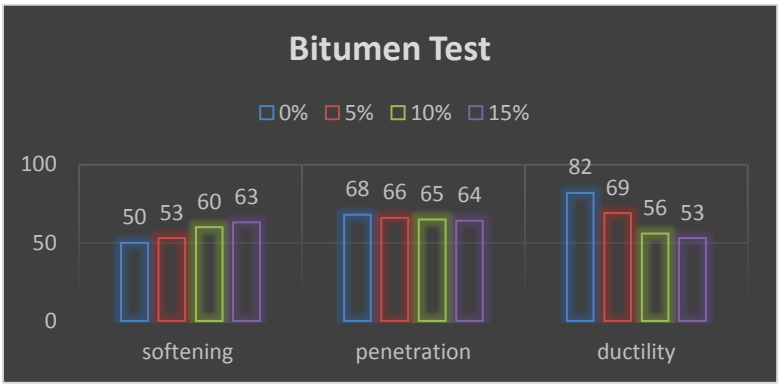

Fig. 6 Graph represent results of various test on bitumen

4.3 Marshall stability test

Table 3: Marshall stability and flow value

Sample No.	Bitumen Content (percent %)	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

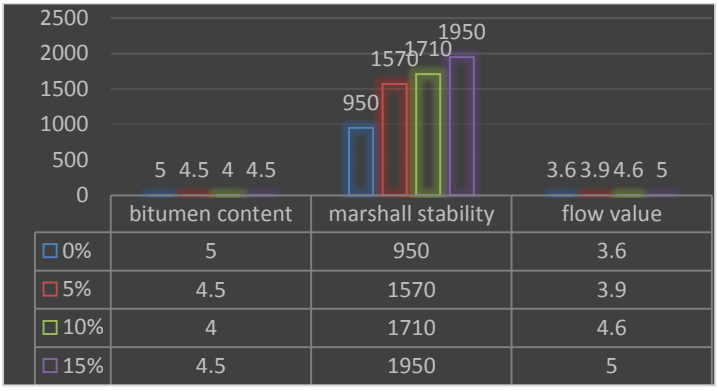

Figure 7 Graph represent Marshall stability and flow value

5. Conclusions

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.

6. Acknowledgement

The author would like to acknowledge Mr. Manish singh kushwaha Asst. Professor, Greater Noida Institute of Technology (GNIOT), Greater Noida Uttar Pradesh India, for his valuable suggestions, encouragement.

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 (Iosr-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

Author

M.TECH SCHOLAR, CIVIL ENGG., GREATER NOIDA INSTITUTE OF TECHNOLOGY, GREATER NOIDA,UP,INDIA