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Utilization of waste material in flexible pavement

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ABSTRACT

Due to increase in population, urbanization, development activities, and the quantity of plastic waste, municipal solid waste and tires are increasing day by day. This waste is disposed by land filling and incineration, which are hazardous and not eco-friendly. The aim of project is to analyze & study how the waste material will be effectively utilized in construction of pavement as a binder material for replacing the content of bitumen. Plastic & tires are cheap in cost and not environmentally friendly. The physical properties of bitumen mix at variation of 10 to 40% of waste plastic (PET) and 10 to 40% of waste rubber is examined by simultaneously combining both plastic and rubber equally from 5 to 20%. According to this research we find optimum percentage of waste plastic, rubber & both combination of (plastic + rubber) is 30%, has given better finish, stability, binding property, resistance to water and durability & Due to use of waste materials, the cost reduction is up to 25 % when compare to ordinary bitumen.

1.INTRODUCTION

- In a recent scenario, a world without roads, cars, motorcycles, trucks is almost unimaginable. India encompasses a road network of over 5,603,293 kilometerS as on 31 March 2016.The second largest road network in the 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. Due to extreme climatic conditions and a steady increase 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 with in 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 are be subject to completely different needs. In view of the long time span of 10 to 15 years between planning infrastructure facilities and its actual completion, followed by an operational period of at least 25 years, more clarity of these future needs, demands and requirements becomes essential in order to make the right choices for tomorrow. Making the 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 and needs. Besides generic developments like shortage of clean environment, space and energy, 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 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 and low maintenance. Scientists and engineers are constantly searching on different methods to improve the performance of bituminous pavements. A common methodology to improve the quality of bitumen is by modifying the rheological properties of bitumen by blending with organic artificial polymers like rubber and 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 and suitability of wastebituminous mix on surface course of the pavement.

1.1OBJECTIVES

1. To study the physical properties of bitumen & crumb

   rubber, , both rubber & PET mixed bitumen & at the various percentage.

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

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

4.To increase the Marshall Stability value

2.LITERATURE REVIEW

1 Review:1

S. Rajesekaran, Dr. R. Vasudevan, Dr. Samuvel Paulraj has been studied “Reuse of Waste Plastic Coated AggregateBitumen Mix Composite for Road Application-Green method” (2013).

Waste plastics both by domestic and industrial sectors can be used in the production of asphalt mix. Waste plastic, mainly used for packing are made up of polyethylene, polypropylene, polystyrene this softening varies between 110◦c-140◦c and they do not produce any toxic gases during heating but the softened plastics have tendency to from a film like structure over the aggregate when they sprayed over the hot

aggregate @ 160◦c. this PCA bitumen mix showed improved binding property and less wetting property and it also showed higher Marshall stability value in the range of 18-20KN and load bearing capacity of the road is increased by 100%. The roads laid since 2002 using PCA bitumen mixes are performing well. This added more value to the dry process as this process helps to dispose 80 percentage of waste polymers usefully by an eco-friendly method and also it reduced the cost to around Rs.3000/km of single lane road as on date.

2 Review: 2

H. K. Sharma, has conducted experiment on "Utilization of Waste Plastic in Construction of Pavement" (2014). He found that Waste plastics - as binder and modifier at 130°C using Thermo gravimetric analysis there is no gas evolution in the temperature range of 130-180°C. 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 and 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.

Review: 3

D R. Manju, Sathya.S, Sheema.Khas 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 shrin/kage. 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.

Review: 4

Vishal Rasal, L Nokfho K, P.M.Wale, Mrunalini Kasar, Anjali Thorat, Raunak Solanki, Ishan Dharmadikari, 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. 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 and 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 and water.

3. Methodology or Materials and methods

3.1 MATERIAL –

- **BITUMEN-**

  Bitumen, also known as asphalt in the United States, is a substance produced through the distillation of crude oil that is known for its waterproofing and adhesive properties. Bitumen production through distillation removes lighter crude oil components, such as gasoline and diesel, leaving the “heavier” bitumen behind. The producer often refines it several times to improve its grade.

- **Coarse aggregates**

Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

Aggregates which possess sufficient strength, hardness, and toughness are chosen, keeping in view the availability and economic consideration. A sets of aggregates were chosen, one set for trial and error testing’s which may have passing 12.5mm and retaining 10mm.

- **Plastic**

  A plastic is a material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow. And Types of plastics are thermosets, elastomers, and thermoplastics. Waste plastics –as binder and modifier at 130°C Thermogravimetric analysis has shown that t here is no gas evolution in the temperature range of 130-180°C. 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 a binder like bitumen to enhance their binding property. This may be an honest modifier for the bitumen, used for road construction.

- **Polyethylene terephthalate -**

Bottles made of polyethylene terephthalate can be used to make lower grade products, such as carpets. To make a food grade plastic, bottles need to be hydrolyzed down to monomers, which are purified and then repolymerized to make new PET. PET is sometime recycled and tends to be both durable and flexible. It can withstand temperature of 80˚ c continuously and 95˚ c for short time. The use of PET will not only strengthen the pavement but also increases its durability. PET comprises of house hold polythene and soft drink bottles that can be collected from local dump sites.

- **CRUMB RUBBER –**

Crumb rubber is actually small pieces of waste tire scrapped from light motor vehicles and whose disposal is a serious menace. The crumb rubber is created by shredding scrap tire, which is a particular material free of fiber and steel. Bitumen-rubber is manufactured by adding graded crumbed rubber to hot bitumen which contains a quantity of heavy extender oil. The rubber never completely dissolves in the bitumen and the product is therefore classed as a nonhomogenous binder. Special manufacturing equipment is needed to manufacture this extremely viscous material

4.Methodology –

Firstly, plastic waste is grounded & converted into powder form; now 3 – 4 % plastic is mixed with bitumen. The melting point of bitumen is increased by using plastic, thus during winter season flexibility is preserved. Shredded plastic works as strong binding material for tar forming the asphalt for lifetime. The ability of bitumen to withstand higher temperatures can be increased by mixing plastic with bitumen. The ratio of melted and mixed plastic with bitumen is particular. Blending occurs when temperature reaches 45.5ÂºC but when plastic is mixed; it remains at 55ÂºC. The test proves that bitumen concrete mixes made from treated bitumen binder fulfilled every Marshall Mix design criteria for road pavement. Another observation is that it can withstand adverse soaking condition for higher duration.

The shredded plastic is to spray over the hot aggregate is melted and spreaded over the aggregate; it gives a thin coating at surface of aggregate. At 140 – 160ÂºC temperature, the coated plastic stays in the softened state, in the next process; hot bitumen (160ÂºC) is added. The aggregates are spreaded over added bitumen. Both the coated plastic sand bitumen is in liquid state at this temperature & capable of easy diffusion at interface. In the further process the contact area is increased. Bitumen is a complex mixture of asphaltenes & maltenes which are long chain hydrocarbon. During the mixing of bitumen with plastic coated aggregate, some part of bitumen diffuses through the plastic layer and binds with aggregate. The plastic layer has bonded with aggregate. During this process, a 3-D internal cross linked network structure is formed between polymer molecules and bitumen constitutes. Thus bond becomes stronger and removal of bonded bitumen becomes difficult.

Mixing procedure at hot mix plant

Plastics waste (cups, bags) made out of PE, PP and PS cut into a size between 2.36mm and 4.75mm.

The aggregate mix is heated to 165Â°C (as per the HRS specification) and transferred to mixing chamber.

Similarly the bitumen is to be heated upto a maximum of 160Â°C (HRS Specification) to have good binding and to prevent weak bonding.

Shredded plastic is added to the hot mix. The plastic gets softened and coated over the surface of the aggregate giving an oily look in 30 – 60 sec.

Waste coated aggregate is mixed with got bitumen and the resulted mix is used for road construction. The road laying temperature is between 110Â°C to 140Â°C. The roller used is 8-ton capacity.

Process for manufacturing bitumen mix road using plastic waste

There are two following processes-

Dry process

In this process, the burning of plastic is not performed and coating is done b softening of plastic waste. The mix for road lying is prepared by mixing of hot aggregate (170ÂºC) andhot bitumen (160ÂºC).

Wet process

The plastic waste [1] is ground and made into powder 6 to 8%. Plastic is added to the bitumen at 160C. The process did not yield a homogenous mix with prominent separated solid deposits of mix therefore wet process was not adopted and another waste material (crumb rubber) has been adopted to add to it.

5.RESULT AND DISCUSSION

Test on aggregate

Table 5.1 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
Without Plastic and crumb rubber	**0%**	**10.53%**	**12.99%**	**2.5**	**3.0%**
With Plastic and crumb rubber	**5%**	**9.94%**	**11.74%**	**2.2**	**2.5%**
With Plastic and crumb rubber	**10%**	**9.19%**	**10.65%**	**2.67**	**2%**
With Plastic and crumb rubber	**15%**	**8.61%**	**8.92%**	**2.68**	**1.11%**

TEST ON BITUMEN –

TABLE 5.2 RESULT OF TESTS OF BITUMEN

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

Marshall stability test

Table 5.3 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

6.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.

SCOPE OF FUTURE STUDIES

1. The studies can be carried out for other grades of bitumen.

2. Other waste materials like Fibers, glass powder etc. can be taken for replacing with bitumen.

3. SEM imaging (Scan Electronic Microscopic).

4. Other tests like flow test, water content test, viscosity test, deflection test (Benkelman beam method, rebound deflection method) can be carried out.

References

[1]. S. Rajesekaran, Dr. R. Vasudevan, Dr. Samuvel Paulraj "Reuse of Waste Plastic Coated Aggregate-Bitumen Mix Composite for Road Application-Green method "American Journal of Engineering Research (AJER)eISSN:2320-0847, p-ISSN: 2320-0936 Volume 2, Issue 11.

[2]. Miss Apurva J Chavan. "Use of Plastic Waste in Flexible Pavement" Volume 2, Issue 4, April 2013 ISSN 2319 – 4847.

[3]. H.K. Sharma, "utilization of waste plastic in construction of pavement" National conference on Recent Research in Engineering and Technology, (NCERT-2015) International journals of advance Engineering and Research Development (IJAERD), (eISSN: 2348-4470, print-ISSN:2348-6406).

[4]. Dr Sowmya N J, Athira R Prasad, "Bituminous Modification with Waste Plastic and Crumb Rubber", 2278-1684, p-ISSN: 2320-334X, Volume 12, Issue 3 (IOSR), May 2015.

[5]. Prakash somani, Vikash maharaniya, Banwarilal kumawat, Rahul dev rangera, "Strengthen of Flexible Pavement by using Waste Plastic and Rubber" (2016).

[6]. Shirish.N. Nemade, "Utilization of Polymer Waste for Modification of Bitumen in Road Construction" SRCC 2013 ISSN-2277-2669.

[7]. Anzar Hamid Mir, "Use of Plastic Waste in Pavement Construction", ISSN (e):2250-3021, ISSN (p):2278-8719, IOSR.

[8]. Mercy Joseph Poweth, Solly George, Jessy Paul "Study on Use of Plastic Waste in Road Construction" (2013).

[9]. Rokade S, "Use of Waste Plastic and Waste Rubber Tires in Flexible Highway Pavements" (2012).

[10]. Amit Gawande, G. Zamare, V.C. Renge, Saurabh Tayde, G. Bharsakale, "An Overview on Waste Plastic Utilization in Asphalting of Roads" (2012).

[11]. Niraj D. Baraiya, "Use of Waste Rubber Tyres in Construction of Bituminous Road – An Overview" (2013). [12]. Mohamed Sulyman, Maciej Sienkiewicz, Jozef Haponiuk, "Asphalt Pavement Material Improvement: A Review" (2014).

[13]. Rishi Singh Chhabra, Supriya Marik, "A Review Literature on the Use of Waste Plastics and Waste Rubber Tyres in Pavement" (2014).

[14]. Yash Menaria, Rupal Sankhla,"Use of Waste Plastic in Flexible Pavements-Green Roads" (2015).

[15]. Anzar Hamid Mir, "Use of Plastic Waste in Pavement Construction: An Example of Creative Waste management", (2015). [15]. Mr. Mahesh M Barad, "Use of Plastic in Bituminous Road Construction" (2015)

[16] 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

[17] 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.