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Use of Waste Tyre Rubber in Road Construction

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ABSTRACT: Now-a-days it is necessary to utilize the wastes effectively with technical development in each field. The old abandoned tyres from cars,trucks, farm and construction equipment and off-road vehicles are stockpiled throughout the country. This leads to various environmental problems which include air pollution associated with open burning of tyres and other harmful contaminants like (polycyclic aromatic hydrocarbon, dioxin, furans and oxides of nitrogen) and aesthetic pollution. They are non-biodegradable; the waste tyre rubber has become a problem of disposal. This paper is intended to study the feasibility of waste tyre rubber as binding material in bitumen, the waste tyre rubber is used with aggregate in different layer and also on the top surface layer mixed with bitumen in percentage (5,10,15) and carried out different test result based on it, finding through it the difference in result by forming normal and rubber pavement and calculate the increase in strength of road pavement and also economically achieve. This is not only minimizes the pollution occurred due to waste tyres but also minimizes the use of conventional aggregate which is available in exhaustible quantity.

KEYWORDS: Rubber aggregate, Crumb rubber, bitumen, Marshal stability test.

I. INTRODUCTION

Day by day with theincrease in number of automobiles in India during recent years the demand of tyres as original equipment and has replacement also increased. As every new tyre produced is designed to go to waste stream for disposal or recycling or reclamation, despite its passage through re-treading process, the number of used tyres being discarded is going to increase significantly. Timely action regarding recycling of used tyres is necessary in view to solve the problem of disposal of used tyres keeping in view the increasing cost of raw material, resource constraints and environment problem including fire and health hazard associated with the stockpiles of the used tyres. The world generate about 1.5 billon of waste tyre annually, 40% of them in emerging markets such as china, India, south America, southeast Asia, south Africa and Europe. In India, all new vehicles have radial tyres so now there are piles of radial tyres here. Analysis indicates that 0.6 million Tons of tyres scrape is generated in the country annually. It is commonly accepted in the tyre industry that about one tyre one person per year is discarded. Since there is no industry group or industry or governmental agency that monitors tyre disposal in the country, the best estimates that can be made are based on tyre production. So supply situation of scrap tyre is only going to be improving in years to come asresult of going vehicle population in India. Mandatory scraping of end of life vehicle, in metros by 2010-11 and across India by 2012-13 is also likely to insure large scale availability of scrap tyre at select locations there by encouraging organized players. The management of scrap tyre has growing problem in recent years, scrap tyres represent one of several special wastes that are difficult to municipalities to handle. Whole types are difficult to landfill because they tend to float to the surface. These stockpiles are also direct loss of energy and resources in addition to fire & health hazards and also environmental issues. The main constituent of tyre is rubber and the largest single application of rubber is vehicle tyres. Also the requirement of tyre is directly related to growth of automobile.



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II. LITERATURE REVIEW

Historically, the use of natural rubber in asphalt was patented in England in the early 1840s (Charles et al., 2000). In 1843, the process of modifying asphalt by using natural and synthetic rubber was introduced. In 1898, rubber was used for the first time as a modifier for asphalt binder. In 1950, the use of scrap tire as a modifier in asphalt was reported, due to its greater abundance and lower cost compared to natural rubber (Mashaan et al., 2014). In the 1960s, a materials engineer named Charles McDonald contributed to the development of a wet process for producing asphalt. Furthermore, he was the first to routinely use asphalt rubber in hot mix batching and surface

treatment, such that he is now widely considered to be the primary catalyst in the emergence and popularity of asphalt rubber as a whole (CDT, 2003). A large number of experimental studies have been conducted over the last several years with the aim of evaluating and improving the design philosophy, properties, specification and materials used in asphalt rubber (Kaloush, 2014; Saberi et al., 2017; Franesqui et al., 2019; Scofield, 1989). By considering the life cycle costs for asphalt rubber paving materials, it is made apparent that asphalt rubber is a cost-effective alternative to many highway pavement applications. Many researchers have claimed that using rubberized bitumen increases the life expectancy of roads and improves the adhesion of aggregates, ultimately leading to better strength and stability (Hicks and Epps, 2018; Deshmukh and Kshirsagar, 2017). In a comprehensive review done by The California Department of Transportation in 2014, the performance of rubberized asphalt over four decades of use led to the conclusion that pavement service life could be extended by using well-designed and properly manufactured asphalt rubber products. Reducing the content of bitumen in pavement construction also provides a noteworthy economical advantage. Moreover, this will lead to an efficient and reasonable use of wasted tire rubber, thus reducing environmental pollution

(Zhou et al., 2014; Asadi et al., 2016). Next to providing an economical advantage, the use of waste tire rubber in the construction of asphalt pavements affords structural advantages in relation to the properties of the pavement. Laboratory experiments showed that the addition of 10% tire rubber crumbs as a blending material in the bitumen improved the properties of the pavement (Arun and Ganesh, 2013). Furthermore, a DOT survey done in 2016 for the Oklahoma Department of Environmental Quality mentioned that as a result of using Ground Tire Rubber (GTR), performance was improved by providing better thermal cracking resistance, superior moisture-induced damage resistance, significant noise reduction, higher rut and crack resistance and better overall durability. It is mentioned in the same DOT survey that many agencies have used GTR in pavement because of its cost effectiveness and environmental benefits (Ghabchi et al., 2016). Similarly, another study was conducted to determine the feasibility of using waste tires (crumb rubber) in the construction of asphalt pavements in Colorado. Two pilot test sections and one control section were constructed and observed. Pilot specification includes both the terminal blend and wet process to modify the asphalt binders. Also, a control section was constructed containing a conventional binder. The study established that the wet process pavement cost might be equal to the conventional pavement cost, since maintenance would not be required for the wet process pavement for about 10 years. In addition, the study demonstrated that the GTR pavements consumption energy is around 3,000 BTU/pound greater than the conventional asphalt pavement (Shuler, 2014). Numerous studies have showed that CRM asphalt pavement has increased pavement performance (Tahmoressi, 2001; Mohammad et al., 2019; Said et al., 2015; Kaloush et al., 2010). Huang and his team presented a comparative study of laboratory and field performance of several applications of CRM hot-mix asphalt in Louisiana. After 5 to 7 years of traffic, the pavement sections constructed with CRM asphalt mixtures showed overall better performance in regards to rut depth and fatigue cracks than the corresponding control sections (Huang et al., 2002). In regards to the effect of aggregate skeleton on mixture characteristic, several studies were conducted to understand the performance of the AR mixture with varying gradations including dense and gap graded (Way et al., 2012; Huang et al., 2002; Wang et al., 2013). Based on a state-of-the-art research review prepared by (Venudharan et al., 2016) many researches have used dense-graded gradation in order to investigate the enhanced performance. Most of the researchers found that rubber modification improved the performance comparing with conventional dense-graded. In sum, it is



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MATERIALS

Aggregate, Bitumen Grade 40/50, Waste Rubber Tyres.

IV. METHODOLOGY

In order to evaluate the quality of rubber waste on road asphalt, laboratory experiments have to be done to identify the performance of the modified asphalt with rubber waste compared to the unmodified asphalt. All the laboratory experiment is based on the standard specification on ASTM and AASHTO.

The objective of Marshall Mix Design (ASTM D 1559) is to determine the optimum aggregate and bitumen mixture to ensure the mixture is durable, stable, sufficient void ratio, flexural, economic and quality.

Testing on bitumen have to be carried out is Ductility Test and Softening Point Test in order to ensure it performs well on t he specification. Both tests were carried out to test whether the modified binder was appropriate. Ductility Test is the consistency test to determine the material stiffness meanwhile Softening Point Test is the consistency test to determine the temperature where the phase change occur in bitumen.

This study used the Marshall method, and the type of mixes that was designed is DBM. Contents of elastomeric base waste used in the mixes were 4%, 8%, 12% and 16% from the optimum bitumen content used in DBM. Minimum three specimens for each of the mix were prepared the optimum waste content.

PREVIOUS RESEARCH ON WASTE TYRERUBBERS

A] Chunk Rubber From Recycled Tires

The feasibility of using large rubber chunks from shredded tires as aggregates in cold mixes for road construction was investigated in this study. The research was directed toward development of a chunk rubber asphalt concrete mix design for low volume road construction using local aggregate, shredded tire rubber chunks and a cationic emulsion. A set of mixes using different combinations of chunk rubber content, emulsion content and fly ash content were tested.

Marshall stability results of mixes with 10% Type C flyash showed optimum emulsion contents of 6.8, 7.3 and 7.8% for 2, 4 and 6% rubber, respectively. The Marshall stability values decreased for increasing rubber contents. Thetarget Marshall stability value of a suitable cold mix at 43°C was required to be 2225 N. Amix with 10% Type C fly ash, 2% rubber and 7% emulsion showed an average Marshall stability value of 1600 N. Based on the Marshall stability results, some of these mixesappeared to be suitable as binder courses or stabilized drainable bases for low volumeroads. If 9 kg of chunk rubber equivalent is produced per tire, then a one km long and 7.3m wide low- volume road with a 100 mm thick base built with this mix can in corporate approximately 3350 tires. This application can minimize the scrap-tire waste problems ofrural communities.

B) Use Of industry Waste and Plastics towards thiAnds end Waste use of Rubber waste Tyers material Worldwide, in sustainability road is the pressing con struction need of the is hour in the being in construction icreasingly encouraged so as to reduce environmental impact. In the highway infrastructure, a large number of original te materials and technologies have been invented to determine their suitability for the design, construction and maintenance of these pavements. Plastics and rubbers are one of them. Also considering the environmental approach, due to excessive use of polythenes in day to day business, the pollution to the environment is enormous. The use of plastic materials such as carry bags, cups, etc. is constantly increasing day by day. Since the polythenes are not biodegradable, the need of the current hour is to use the waste polythene insome beneficial purposes. The main aim of this study is to focus on using the available waste/recycled plastic materials and waste rubber tyres present in abundant which can be used economically and conveniently. The use of these materials as a road construction proves ecofriendly, economical and use of plastic will also give strength in the sub-base course of the pavement



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C) Industrial Waste In Flexible Pavement

A test pit, each of size 3m long, 1.5m wide to an average depth of 0.8m is prepared . Out of which, 0.5m depth is for laying subgrade, 0.15m is subbase and0.15m for base-course. In the prepared test pit, the sand soil mixed with water at OMC is laid in10 layers such that each layer of 0.05m compacted thickness amount to a total thickness of 0.5msubgrade is laid in the excavated pit. On the prepared sand sub-grade murrum / flyash subbase material mixed with water content at OMC in 2 layers, each of 0.075m compacted thickness to atotal thickness of 0.15m is laid. The reinforcement materials viz; waste plastics and waste tire rubber were (optimum percentage based on lab CBR) mixed uniformly throughout the subbase material.

In this investigation six model flexible pavements were prepared in field each of size $3m \times 1.5m \times 0.8m$, with different alternatives as given in table: 1. Sand soil is used as a subgrade soilfor all the tests. Out of six models flexible pavements three tests with murrum subbase and oth r three tests with flyash subbase were conducted in this study. For all the six alternative stretches,WBM-II is used as base course was laid uniformly.

| S.No | Subgrade | Subbase | Base Course |
|------|-----------|----------------------------------|-------------|
| 1 | Sand soil | Murrum | WBM II |
| 2 | Sand soil | Murrum + waste plastic strips | WBM II |
| 3 | Sand soil | Murrum + waste tyre rubber chips | WBM II |
| 4 | Sand soil | Flyash | WBM II |
| 5 | Sand soil | Flyash + waste plastic strips | WBM II |
| 6 | Sand soil | Flyash + waste tyre rubber chips | WBM II |

Table No.-1Details of Model Flexible Pavement

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D)Waste Rubber Tyres In Construction Of Bituminous Road

Prof. Justo et al (2002), at the Centre for Transportation Engineering of Bangalore University compare the properties of the modified bitumen with ordinary bitumen. It was observed that the penetration and ductility values of the modified bitumen decreased with the increase in proportion of the plastic additive, up to 12 percent by weight. Therefore the life of the pavement surfacing using the modified bitumen is also expected to increase substantially in comparison to the use of ordinary bitumen.Shankar et al (2009), crumb rubber modified bitumen (CRMB 55) was blended at specified temperatures. 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 (60/70) also. This has resulted in much improved characteristics when compared with straight run bitumen and that too at reduced optimum modified binder content (5.67 %). Mohd. Imtiyaz (2002) concluded that the mix prepared with modifiers shows: Higher resistance to permanen

E)Road Base Construction

The 300 m long road embankment was constructed in July 1999. Initially five layers of the whole tyre sidewalls were manually placed on the subgrad in overlapping pattern to provide a clear working surface and to elevate tyre shreds above the ground water table. Then 300 mm tyre shreds were hauled to the site unloaded directly over the sidewalls and were spread to the desired thickness of 1500 mm with the backhoe in layers. The tyre shreds were compacted with five passes of small bulldozer, with passes perpendicular and parallel to the road, and werefinally covered with 450 mm thick gravel fill. The construction sequence of the Waste rubber tyres were collected from roads dumpsites and waste-buyers. The collected waste sides, tyres



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F) Addition Of Rubber Aggregate

2.15m high road is shown in Figure 1



WORLD SENARIO ON WASTE TYRES

Each year approximately 285 million tires are added to stockpiles, landfills or illegal dumps across the United States . The EPA estimates that the present size of the scraptire problem is two to three billion tires. If the national rate of tire generation is used, it is estimated that on the average, one scrap tire per person per year is gen- erated in Kansas. This translates to ap- proximately

2.4 million tires per year in Kansas. The current estimate of the num- ber of accumulated scrap tires in the state is between 4.3 and 5.5 million. Cloud, Coffey, Leavenworth and Sedgwick Coun- ties have the most scrap tires, to talling over 3.3 million. The case of Cloud County, a rural county with approximately 11,000 people, is particularly interesting. The esti- mated number of accumulated tires is slightly over half a million. The large number of tires accumulated over the years and currently being generated creates a disposal

USE OF TYRES IN COASTAL AND problem in the rural areas kan-sas. waste tyres were were sorted as cut per in the the required form of sizes aggregate for the aggregate of sizes . The ranging from 22.4mm to 6.00 mm (as per IRC-SP20) in the tyre cutting machine which is shown in picture. The waste rubber tyres can be managed as a whole tyre, as slit tyre, as shredded or chopped tyre, as ground rubber or asa crumb rubber product. The rubber of tyre usually employed bituminous in mix, in the form of rubber particles are subjected to a dual cycle of magnetic separation, then screened and recovered in various sizes and can be called asRubber aggregate as shown in Figure.2. It was cleaned by de-dusting or washing if required. The rubber pieces (rubber aggregate) were sieved through 22.4 mm sieve and retained at 5.6 mm sieve as per the specification of mix design and these were added in bituminous mix, 10 to 20 percent by weight of the stone aggregate These rubber aggregate were mixed with stone aggregate and bitumen at temperature between 1600c tobit1700uminouc fors propermix. Amixings the of waste rubber tyres are thermodynamically set, they are not supposed to melt in the bitumen, at the time of mixing of rubberaggregate, stone aggregate and bitumen in hot mix plant.



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Fig.No.-2RubberAggregateEquipment

STABILITY ANALISIS



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RIVER ENGINEERING

Each year in the India, Coastal and river engineering schemes consume about 1 million tones of amour-stone and about 2 lakhs tones of largely sea-won aggregates. This consists almost entirely of primary materials such as marine dredged sand and gravel for beach recharge schemes and high quality rock predominantly from coastal quarries. With increased occurrence of severe river flooding and the predicted acceleration of sea level rise it is expected that the increase in the demand for materials will be proportionately greater in this sector of civil engineering than for general construction. It is therefore important that coastal and river engineers address their resource usage and reduce this consumption wherever possible. In the form of tyre bales it may be possible to utilize around an estimated 2 million tyres per annum over the next 5-10 years in port, coastal and river engineering schemes - around a fifth of the total diversion from landfill required. Although there is continuing demand for large quantities of primary aggregates, the costs are rising due to measures such as the aggregate tax, and, ultimately, the supply of economically accessible primary aggregate is limited. This is increasingly encouraging the consideration of alternative and secondary materials such as used tyres.

ADVANTAGES

A)Environmental: Discarded tyres provide the source for the rubber granules used in rubber asphalt. It is estimated that the annual amount of rubber available from discarded tyres is lakh tons, an amount sufficient to modify the pavements on 4000 kilometer of two-lane .

B)De-icing: Rubber asphalt pavements have been reported to keep themselves de-iced. The patent holder claims deicing occurs by compression of protruding rubber granules which sufficiently deform the pavement under the weight of traffic.

This causes fracture of the ice layer formation. Following this, wind created by passing vehicles clears the ice from the roadway. *C*)*Noise Reduction:* Reductions of up to 10 dB in noise level in comparison with noise levels of conventional pavement surfaces have been reported.



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D)Skid Resistance: The surface texture and protruding rubber granules are reported to give the pavement improved skid resistance during dry, wet, and icy conditions. Measurements have shown a reduction in stopping distance averaging 25% under icy road conditions.

E)Hydroplaning and Water Spray: The high content of coarse aggregate in this product results in a coarse surface texture with good surface drainage, which reportedly eliminates hydroplaning and reduces water spray.

F)Sanding and Salting:

With improved skid resistance and deicing characteristics, the need for sanding and salting would be greatly reduced. This would result in a reduction of maintenance costs and corrosive damage to vehicles.

G)Increases the drainage properties of road pavement.

H)There is a no compression takes place due to continuousloading of traffic.

I)Vibration attenuation property will be increase.

J)Decreases the maintenance cost of road pavement.

HAZARDS OF TYRE WASTE

- 1) This waste tyres are produces carbon by burning process.
- This amount of tyres is very large manner so it becomes dangerous as well as uncomfortable to placing, because of Land problems to our country.
- 3) Potentially harmful substances were found exposed to highly acidic solutions.
- 4) Aside from the persistent annoyance, mosquitoes havebeen shown to spread various dangerous diseases.
- 5) Equally hazardous are tyre fires, which pollute the air with large quantities of carbon smoke, hydrocarbons and residue.
- 6) Not only are these tyre mounds eyesores, they are also environmental and health hazards. The little pools of water retained by whole waste tyres create an ideal breeding ground for mosquitoes.
- 7) These fires are virtually impossible to extinguish oncestarted.

SCENARIO OF OUR PROJECT

From all this research papers we are concluding that the useof rubber waste tyre only in between aggregate, we are using that rubber waste in aggregate mix and also in top surface layer the fine powder of rubber waste mixed with bitumen, by proper binding of this mixes which gives us a greater strength than the normal bitumen and by mixing it which is economical as well as it reduces the pollution occurred due to waste tyre. Also we are conducting a different five test on aggregate and five test on bitumen by replacing the rubber in percentage (5,10,15) after conducting all the tests we are making a two sections of road one is normal and other is rubber mixed and comparing on it different basis.

V. CONCLUSION

1Addition of waste tyre in rubber aggregate modifies the flexibility of surface layer.

2The permanent deformation and thermal cracking arereduced in hot temperature region.

3The main properties of rubber is sound absorbing, soreduced the noise pollution of heavy traffic roads

4Conventional stone aggregate can be saved to the certain quantities

5The waste rubber tyre are used in road construction

,so improved the quality of road

6Waste tyre rubber is used with aggregate in different layer and on the top surface layer mixed with bitumenin percentage (5,10,15) by replacing it which increases its properties of bitumen as well as aggregate & minimizes the pollution occurred due to waste tyre and also use of rubber waste is economical as compared to other material. 7By replacing the rubber in bitumen the strength will be increased.



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