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Comprehensive Literature Review on use of Waste Tyres Rubber in Flexible Road Pavement

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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.

1] 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 as result 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 tyres 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.

2] PREVIEUSRESEARCH ON WASTE TYRE RUBBERS

A] Chunk Rubber From Recycled Tires

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

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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 43ºC was required to be 2225 N. Amix with 10% Type C fly ash, 2% rubber and 7% emulsion showed an average Marshallstability 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 incorporateapproximately 3350 tires. This application can minimize the scrap-tire waste problems ofrural communities.

B)Use Of Waste Plastics And Waste Rubber Tyers

Worldwide, sustainability is the pressing need ofthe hour in the construction industry and towards this enduse of waste material in road construction is beingincreasingly encouraged so as to reduce environmentalimpact. In the highway infrastructure, a large number oforiginate materials and technologies have been inventedto determine their suitability for the design, constructionand maintenance of these pavements. Plastics andrubbers are one of them. Also considering theenvironmental approach, due to excessive use ofpolythenes in day to day business, the pollution to theenvironment is enormous.The use of plastic materialssuch as carry bags, cups, etc. is constantly increasing day by day. Since the polythenes are not biodegradable, theneed of the current hour is to use the waste polythene insome beneficial purposes.The main aim of this study is tofocus on using the available waste/recycled plasticmaterials and waste rubber tyres present in abundantwhich can be used economically and conveniently. Theuse of these materials as a road construction proves ecofriendly,economical and use of plastic will also givestrength in the sub-base course of the pavement

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 sub-grade, 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 subbasematerial 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 tirerubber were (optimum percentage based on lab CBR) mixed uniformly throughout the subbasematerial.

In this investigation six model flexible pavements were prepared in field each of size 3m ×1.5m × 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 otherthree 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.

Table No.-1Details of Model Flexible Pavement

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

Source-Vol. 13, Bund . D

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 were finally covered with 450 mm thick gravel fill. The construction sequence of the 2.15 m high road is shown in Figure.1

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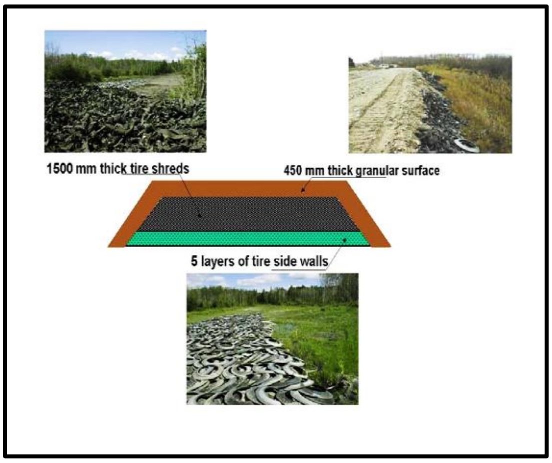

F) Addition Of Rubber Aggregate

Waste rubber tyres were collected from roads sides, dumpsites and waste-buyers. The collected waste tyres were sortedas per the required sizes for the aggregate. The waste tyres were cut in the form of aggregate of sizes 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 in bituminous mix, in the form of rubber particles aresubjected 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) weresieved through 22.4 mm sieve and retained at 5.6 mm sieve as per the specification of mix design and these were addedin bituminous mix, 10 to 20 percent by weight of the stone aggregateThese rubber aggregate were mixed with stoneaggregate and bitumen at temperature between 1600c to 1700c for proper mixing of bituminous mix.As the wasterubber 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.

Fig.No.-2RubberAggregateEquipment

3] 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 scrap tire 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, totalling 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 problem in the rural areas kan-sas.

4] USE OF TYRES IN COASTAL AND 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.

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STABILITY ANALISIS

Fig. No.-3 Stability Analisis

LANDFILL PURPOSE

Fig. No.-4 Landfill Purpose

5] 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 de-icing 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.

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 continuous loading of traffic.

I) Vibration attenuation property will be increase.

J) Decreases the maintenance cost of road pavement.

6] HAZARDS OF TYRE WASTE

1) This waste tyres are produces carbon by burning process.
2) 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 have been 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 once started.

7] SCENARIO OF OUR PROJECT

From all this research papers we are concluding that the use of 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.

8] CONCLUSION

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

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

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

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4 Conventional stone aggregate can be saved to the certain quantities
5 The waste rubber tyre are used in road construction ,so improved the quality of road
6 Waste tyre rubber is used with aggregate in different layer and on the top surface layer mixed with bitumen in 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.
7 By replacing the rubber in bitumen the strength will be increased.

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