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Construction of Flexible Road Pavement by using Waste Rubber Tyre

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ABSTRACT

Waste tires have recently proved to be an ecological and financial burden in many regions of the world. Old abandoned tyres from cars, trucks, farm and construction equipment and off-road vehicles are stockpiled throughout the country. In 1989, nearly two core waste tyres were estimated to be stockpiled across the India. Today, that number is growing by more than 85 crore annually (i.e. near about 23,00,000 tyres per day) have been ending up as waste. Waste tyres have been a disposal problem in the past and are continuing to accumulate throughout the India and globe today. Now a days we are using the materials for road pavements generally are, bitumen, concrete, earth, etc. but these materials are not sufficient to fulfill our demands. So we introduced a new technique for road construction. In this process we collect the waste tyres of various vehicles. Waste tyres are crushed and various materials from it like steel wire, gas, oil and carbon black are separated to produce crumb rubber (fine particles).Then the mixture of crumb rubber and asphalt is applied on road surface. Development of modified materials especially the use of asphalt and rubber crumb from discarded tyres of vehicles in pavement construction is one of the steps to reduce environmental concern in many countries. Modified binders generally exhibit decreased temperature susceptibility and potentially improve mix performance. The advantages resulting in the use of scrap tyre include increased fatigue life or fatigue resistance, reduced reflective cracking and low temperature cracking, improved tensile strength, ductility, toughness, adhesion, resilience, tenacity, durability, and skid resistance.

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I. INTRODUCTION

Day by day with the increase 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.

Percentage of Daily Waste in Our Country:

Old abandoned tyres from cars, trucks, farm and construction equipment and off-road vehicles are stockpiled throughout the country. Waste tyres have been a disposal problem in the past and are continuing to accumulate throughout the India. today. Recent figures from the India Environmental Protection Agency (IEPA) show that over 85 crore waste tyres are being added annually to the estimated 2 crore tyres currently stockpiled around the country. Waste tyre stockpiles constitute environmental and health hazards by producing air pollution from tyre stockpile fires and breeding for potential disease carrying mosquitoes and vermin. Under recent environmental legislation that encourages the reuse or recycling of waste products in the India, the use of discarded tyres has been increasing. The IEPA estimated in 1990 that 11% of the waste tyres generated in the India annually were converted into energy and 7% were recycled into new products. In order to avoid even larger stockpiles across this country, alternate ways of using waste tyres must be implemented.

The most desirable approach to reduce waste tyre stockpiles is to recover the resource by recycling. However, tyres are now being burned throughout the nation as a fuel source. Tyre Derived Fuel has also become popular in Minnesota, USA. Where from 60 to 80 percent of the tyre processed are used up by this method annually. It has been estimated that waste tyres stockpiles will be eliminated in Minnesota by 1996, largely due to the processing off tyres as TDF. Only large scale methods to use waste tyres are through burning for electric power generation, production of cement in cement kilns, energy to run pulp and paper mills, and recycling at tyres-to-energy facilities.

II. LITERATURE SURVEY

1) **"**Use of Waste Rubber Tyres In Construction Of Bituminous Road." Neraj D. Baraiya(Volume 2, Issue 7, July 2013).

The use of four wheeler, two wheeler vehicles etc. is increasing day by day. As a result amount of waste tyres also increasing. Waste tyres in India are categorized as solid or hazardous waste. It is estimated that about 60 per cent of waste tyres are disposed via unknown routes in the urban as well as rural areas. This leads to various environmental problems which include air pollution associated with open burning of tyres (particulates, odor, visual impacts, and other harmful contaminants such as polycyclic aromatic hydrocarbon, dioxin, furans and oxides of nitrogen) and aesthetic pollution. Therefore, it is necessary to utilize the wastes effectively with technical development in each field. The waste tyres can be used as well sized aggregate in the various bituminous mixes if it is cut in the form of aggregate and can be called as rubber aggregate. This not only minimizes the pollution occurred due to waste tyres but also minimizes the use of conventional aggregate which is available in exhaustible quantity.

2) "Usage of Waste Tyre Rubber In Bituminous Concrete."

Due to overall development, new roads are being constructed, and the ever increasing population has raised the vehicular density from last few decades. The wear and tear of tires from these vehicles is undoubted. So a large number of scrap tires are being generated. A large number of waste and worn out tires are already in existence and with an annual generation rate of 15-20% each year. These tires are discarded indiscriminately or stockpiled. The used tires pose a great threat to human health and environment, since they are non-biodegradable; the waste tire rubber has become a problem of disposal. This paper is intended to study the feasibility of the waste tire rubber as a blending material in bitumen, which is used for road construction. The Waste tire rubber appears to possess the potential to be partially added in bitumen, providing a recycling opportunity. If Waste or used tire rubber can be added in bitumen for improving the properties, and disposing off the tires, thus the environmental gains can be achieved.

3) "On The Use of Waste Plastics And Waste Rubber Tyres In Pavement." Rishi Singh Chhabra, SupriyaMarik (Volume 1, Issue 1, April 2014).

Worldwide, sustainability is the pressing need of the hour in the construction industry and towards this end use of waste material in road construction is being increasingly encouraged so as to reduce environmental impact. In the highway infrastructure, a large number of originate 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 in some 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. Plastic materials have become the corner stone of our lives, so it leads to generation of huge quantity of plastic waste. There is an immediate need to improve the properties of pavement in the present scenario since a steady increase is observed in areas like wheel loads, tyre pressure, change in climatic conditions and daily wear and tear which affect the performance of bituminous mix pavement in a huge amount.

4)"Performance of A Road Base Constructed With Shredded Rubber Tires" R. A. Khan and A. Shalaby.

Waste tires have recently proved to be an ecological and financial burden in many regions of the world. In Canada, an equivalent of one waste tire per capita is added to the stockpiles annually. The road construction can utilize a large quantity of scrap tires but there is a shortage of technical data on design and performance. Given this lack of technical data, a gravel-surfaced lightweight road embankment was constructed in Manitoba on a soft ground using large size (300 mm) tire shreds in the base layer. This paper reports the performance-monitoring program of the road and development of a layered elastic-isotropic deflection model based on one-dimensional constrained compression laboratory tests on three sizes of the tire shreds. Design guidelines for roads constructed using shredded rubber tires are presented

based on the laboratory testing, numerical model and field performance of the road.

III. OBJECTIVE

Environment- There is huge problem of disposal waste tyre by using this waste tyre we protect the environment.

Strength- By replacing rubber in bitumen it increasing its strength which gives better strength as compare to normal road.

Economy- As compare to waste rubber bitumen is costlier by replacing this waste tyre in bitumen we can reduces the cost, hence economy can be achieved.

The main property of rubber is reducing noise pollution, friction resistance and also skid resistance.

It increases drainage properties of road pavement.

It also decreases maintenance cost of road pavement.

IV. PROPOSED METHODOLOGY

For this research on, large no of waste tyre collected. These waste tyre cut to the crushing plant in various sizes (80 mm to micron).The waste rubber use not only in bitumen but also aggregate in percentages of 5, 10, 15 by using wet process. The different test conduct on aggregate (Impact, Crushing, Abrasion, specific Gravity & Water Absorption Test) as well as on bitumen (Penetration, Ductility, Softening, Viscosity & Marshall Stability Test). There are a large number of ways to manage the waste rubber tyres. It can be in the form of whole tyre or slit tyre, chopped tyre, ground rubber or as a crumb rubber product. The rubber tyre employed in bituminous mix in the form of rubber particles, when subjected to a dual cycle of magnetic separation are then screened and recovered in various sizes, thus giving rise to the product called “Rubber Aggregate“. Various processes like de-dusting and washing are used to clean the waste rubber-tyre. All the rubber pieces are sieved through 22.4 mm sieve and retained through 5.6 mm sieve as per the specifications of mix design. These clear pieces are added in bituminous mix, 5 to 15% by weight of stone aggregate. Then, these well – sieved and cleaned rubber aggregate is mixed well with stone aggregate and bitumen at temperature of about 160^0C-170^0C for the proper mixing of bituminous mix. The waste rubber tyres are thermodynamically set, thus they are not melted in bitumen at the time of mixing altogether in a mix plant. Large quantities of waste rubber tyres are collected from road sides, dumpsites and waste – buyers. The collected waste tyres are sorted as per the required sizes for the mixing purposes. The waste tyres are cut in the form of aggregate size usually ranging from 22.4mm to6.00mm (as per IRC:SP20) in the tyre cutting machine shown in the figure below Selection Criteria For PMB And CRMB Based On Atmospheric Temperature.

Fig 1. Road Base Construction

Process:

One of the main methods of used tyre alternative management is the production of rubber granulates and powder through mechanical granulation. During mechanical granulation of tyres, the metal and synthetic fibres contained therein are being removed, as well as any other foreign part. This results to a 100% pure rubber.

Rubber granulates and rubber powder can be used in many ways such as raw material for creating a variety of new rubber products, in constructing synthetic lawn for 5X5 fields and generally shock absorber sport flooring, in creating safe flooring for playgrounds and in many other cases. Also the use of such products in public works such as road asphalting by adding rubber in the asphalt, in the construction of draining technical works (Waste Disposal Areas), in creating sound insulation panels in large road or railway axes etc. is of high importance.

Main parts deriving from old tyres are:

- Rubber granulates in various granulations
- Rubber powder
- Scrap Steel
- Recycled textile

Anyone investing in a tyre recycling plant expects it to be a cost effective operation. Besides a fixed amount paid to the operator for the disposal of the old tyres, further income also has to be made from the neatly sorted scrap. The sales income naturally depends on the quality of the output material and the pricing structure depends on processing that is as efficient as possible. For this purpose, we has designed a three-stage processing principle (shredding, granulating line, fine grinding), which ultimately produces very high quality materials for recycling. That could be shreds for thermal recycling, predominantly in the cement industry, rubber granules between 0 and 4 millimeters for various applications and, as a premium product, a genuine secondary raw material in the form of an active rubber powder. This can be directly added back to the raw material used in the production of rubber.

The machines for the three-stage process have also been designed by the company from Gechingen. Pre-shredding is done by a UNI-CUT UC rotary shear. This shreds complete car and truck tyres up to a diameter of 1.4 meters. What is special about this is that the textile and steel beading can be left in the tyre to start with and does not require a great deal of expense and effort to be sorted out by hand. This step is done mechanically in the course of the process. The final result is even, approximately hand-sized pieces of tyre (shreds) are produced.

Production - 1st cutting

During first cutting of the production process, the used tyres are being cut into the appropriate size in order to be processed in the granulation pressing machine.

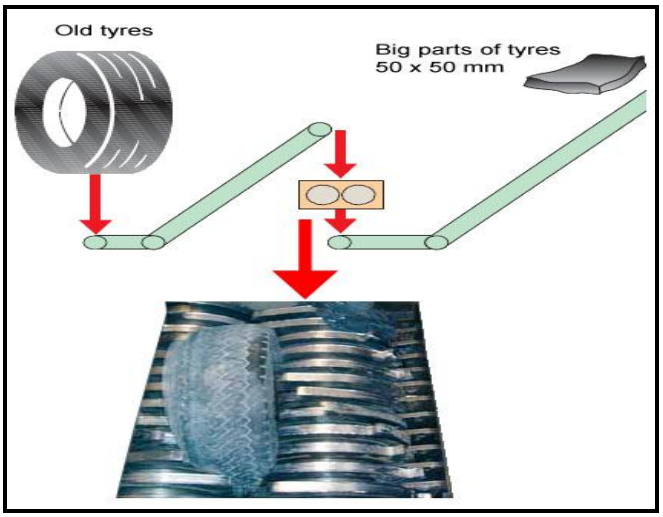

Fig 2. Cutting

Production - Pressing Machine

The granulation pressing machine process and cuts the material giving it its final form. This is followed by the metal separation process.

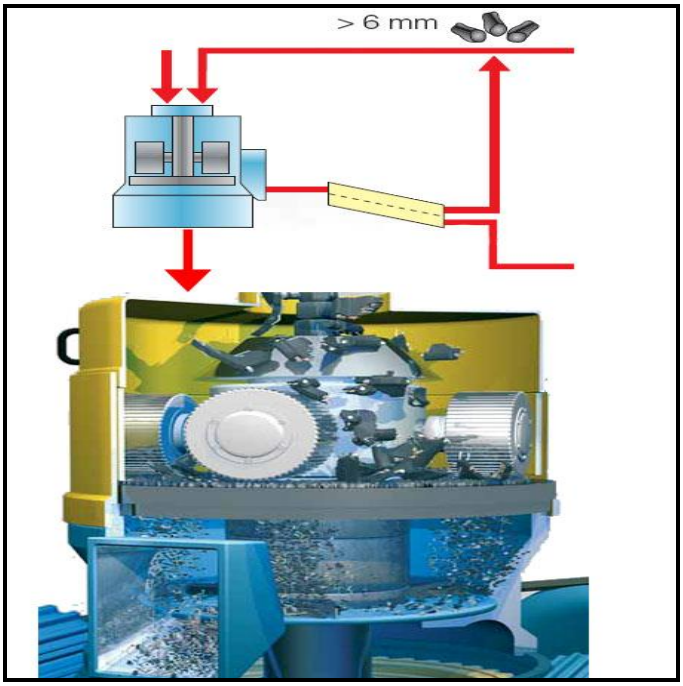

Fig 3. Pressing Machine

Productions - Separation of metal and textile:

The material is being transferred from the pressing machine to a sorting machine where any metal product is removed from the tyres by the use of powerful magnets. This is how the rubber scrap steel results. Following, the material that is not cut in the appropriate dimensions, returns back to the cutting press machine for reprocess, while the one appropriately cut, is transferred to the final stage.

In this stage the textile contained in the tyres is being removed gravitationally by the use of air. This is how the rubber textile results.

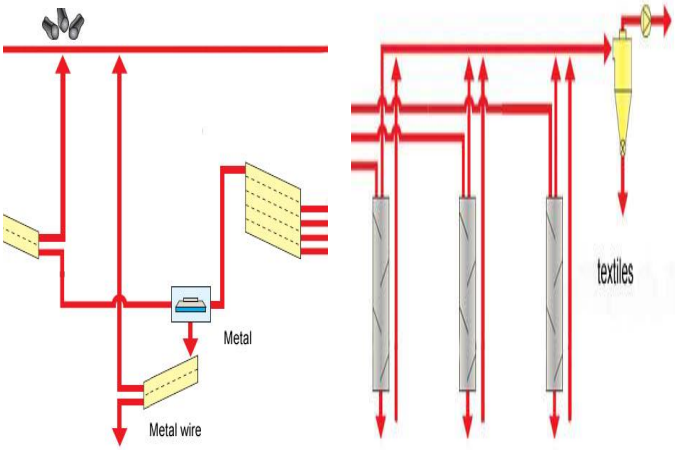

Fig 4. Separation of Metal Wire and Textile

Production - Separation of rubber:

In this final stage of the production process, the final selection of the rubber granulates is being done according to their dimensions. Afterwards, rubber granulates are being weighted and packed into giant bags of 2m.

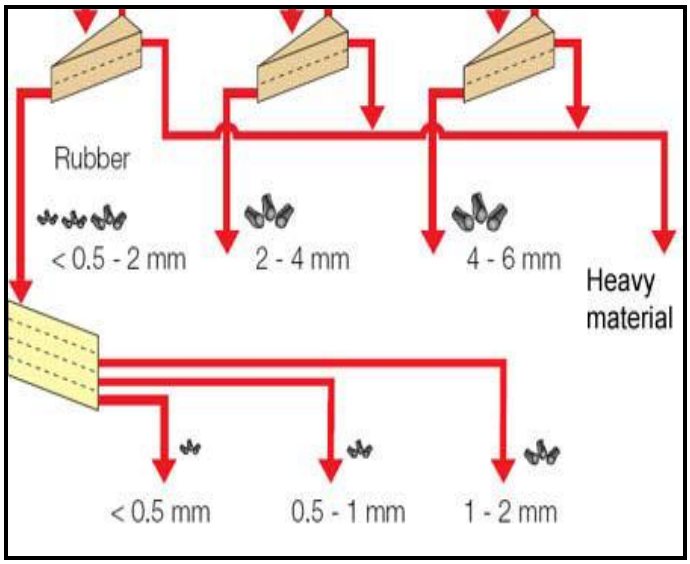

Fig 5. Separation of Rubber According to The Diameter of Grains

Products:

A typical scrap tyre (passenger car) weighs approximately 9 kilograms (20 pounds) and will provide approximately 60% rubber, 20% steel and 20% fiber and other waste products .The paving industry uses 1 to 2 million tyres per year. Each metric ton of Hot Mix Asphalt which contains rubber can utilize 2 to 6 tyres.

Below is the output percentage of products-

1. Crumb rubber- 55 to 65%,
2. Steel ware- 10 to 15%,
3. Fuel oil- 10 to 15%
4. Gas- 5 to 10%

V. CONCLUSION

After carefully performing the above test on aggregate and bitumen it is concluded that as per IRC specification the results of replacing 10% of rubber has gives a better strength and stability also reduces the problem of disposal of waste tyre and help to make a healthy environment.

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