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European Journal of Advances in Engineering and Technology, 2022, 9(4s):128-132
International Conference on Tech Trends in Science & Engineering (ICTTSE) 2022
Suryodaya College of Engineering & Technology, Suryodaya Polytechnic, Nagpur, Maharashtra, India

Research Article ISSN: 2394 - 658X

Construction of Bitumenous Road Pavement by using Waste Rubber Tyre

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ABSTRACT

The growth rate of vehicles is the backbone of economic development of any country. India is the second fast growing automobile industry in the world. The increasing consumption of waste tyre has generated many problems such as increasing landfill space, environmental pollution and causing health hazards. Parallel to this is the increasing of roads construction as a result of heavy traffic on roads. This study reviews to the use of crumb rubber (waste tyres in powder form) in bitumen using the wet process. The design or life span for all highways and urban roads is 10 – 20 years. Unfortunately, damages or distresses on pavements are still occurring before reaching the maximum period of the designed road serviceability. Among the major influencing factor that is contributing to this distress is the repeated heavy traffic loading on the road surfaces. Moreover, the use of waste crumb rubber in road construction as a pavement surface has a better skid resistance, fatigue crack resistance and increased rut resistance. The review includes physical tests that are used to determine the physical properties of bitumen and modified crumb rubber mix. The physical tests involve penetration test, softening point test, and ductility test. The expectations from the study are to develop bitumen with waste crumb rubber that would minimize the costs of bitumen.

Key words: Bitumen, Crumb Rubber, Flexible Pavement, etc.

INTRODUCTION

In India, over 15 million waste tyres are generated annually. 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. Aside from the persistent annoyance, mosquitoes have been shown to spread various dangerous diseases. Equally hazardous are tyre fires, which pollute the air with large quantities of carbon smoke, hydrocarbons, and residue. These fires are virtually impossible to extinguish once started.

It has been an established fact that normal bituminous course cannot cope up with the following problems:

i. Increasing traffic on road / overloading of vehicles leading to undulations, rutting, cracking, deformations, potholing, and shortening of the life of asphaltic pavements.
ii. High range of temperatures causing pavements to become softer in summer and brittle in winter.
iii. Rains/water causing extensive stripping problems in asphaltic pavements.

To overcome the above problems in the entireworld it has become a regular practice to use modifier as additives to strengthen the asphalt for making longer lasting asphalt mixes.

The addition of rubber gives the additional binding strength, increasing elasticity and softening point of the bitumen. Carbon present in rubber acts as an anti- oxidant and prevents asphalt from ageing & oxidization.

Timely action regarding recycling of used tyres is necessary in view to solve the problem of disposal of used tyreskeepingview the increasing cost of raw material, constraints and environment problem including fire and health hazard associated with the stockpiles of the used tyres. The world generates about 1.5 billon of waste tyre annually, 40% ofthem 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 radialtyres 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.

The management of scrap tyre has growing problemin recent years, scrap tyres represent one of severalspecial wastes that are difficult to municipalities tohandle. Whole tyres are difficult to landfill becausethey tend to float to the surface. These stock piles are also direct loss of energy and resources in additionto fire & health hazards and also environmentalissues. The main constituent of tyre is rubberand the largest single application of rubber isvehicletyres. Also the requirement of tyreis directly related to growth of automobile.

Hazards of tyre waste

1) This waste tyres are produced 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 this 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.

LITERATURE REVIEW

Many types of research were carried out by many scholars and professors of civil engineering in this field, to find the ways and crumb rubber mix in conventional bitumen to improve in engineering properties of bitumen.

Abdelrahman and Carpenter, (1999) From the study he determines that the various properties of CRMB vary with blending temperature and blending time. The optimum blending temperature and blending time found out 175ºC and 45 minutes respectively for preparing high-quality CRMB.

Becker et al, (2001) claimed that blend properties will be influenced by the amount of crumb rubber added to the bitumen. Higher amounts indicated significant changes in the blend properties. As rubber content generally increases, it leads to increased viscosity, increased resilience, increased softening point and decreases penetration at 25°C.

Mashaan et al, (2011a) The penetration is a measure of hardness or softness of bitumen binder which shows an effect by adding crumb rubber to bitumen binder; it decreases as rubber content is increased. The penetration shows lower values as rubber content increases at different mix conditions of rubberized bitumen binder, indicating that the binder becomes stiff and more vicious. The softening point refers to the temperature at which the bitumen attains a particular degree of softening. The use of crumb rubber in bitumen modification leads to an increase in the softening point and viscosity as rubber crumb content increases.

SiddharthRokade, (2012) The Crumb Rubber was added to 60/70 grade bitumen in varying percentage. The mix was prepared with 5 % bitumen and the varying percentages of Crumb Rubber. The bitumen, when mixed with Crumb Rubber, is termed as Crumb Rubber Modified Bitumen (CRMB). The results observed that the Marshal Stability Value is increased from 4% to 12% Crumb Rubber and then it is decreased 15% of Crumb Rubber of the weight of bitumen is the optimum dose for getting enhanced strength characteristics of the mix.

NuhaS.Mashaan, (2012) In their study presented the application of crumb rubber modifier in the asphalt modification of flexible pavement. From the results of the previous study, it aspires to consider crumb rubber modifier in hot mix asphalt to improve resistance to rutting and produce pavement with better durability by minimizing the distresses caused in hot mix asphalt pavement. Hence, road user would be ensured of safer and smoother roads.

NabinRanaMagar, (2014) investigates the performance of crumb rubber modified bitumen by varying the sizes of crumb rubber. The test results of common laboratory test on plain bitumen and crumb rubber modified bitumen shows that the penetration values and softening points of plain bitumen can be improved significantly by modifying it with the addition of crumb rubber which is a major environmental pollutant. The best size to be used for crumb rubber modification is suggested as (0.3-0.15mm) size for commercial production of CRMB.

Rishi Singh Chhabra (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 been invented to determine their suitability have been for the design, construction and maintenance of these struction pavements. Rubbers are one of them.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 materials and waste rubber tyres present in abundant which can be used economically and conveniently. The use of these rials as materials a road construction proves ecofriendly, economical and use of plastic will also give strength in the sub-base course of pavement.

OBJECTIVE

1. Light weight
2. Free Drainage
3. Low earth pressure
4. Good thermal insulator
5. Durability
6. Compressible
7. Vibration Damping
8. Low- Cost
9. Reducing noise pollution
10. Friction resistance and also skid resistance.
11. It increases drainage properties of road pavement.
12. It also decreases maintenance cost of road pavement.

METHODOLOGY

Crumb Rubber

The major component of crumb rubber modifier (CRM) is scrap tyre rubber which is primarily natural and synthetic rubbers and carbon black. Automobile tyres have more synthetic rubber than truck tyres. Truck tyres contain a higher percentage of nature rubber than automobile tyres. Advances in tyre manufacturing technology have decreased the difference in chemical composition between the types of tyre rubber. The typical bulk CRM produced in today's market is uniform in composition. The average car tyre contains ten types of synthetic rubber, four types of natural rubber, four types of carbon black, steel cord, bead wire, and 40 kinds of chemicals, waxes, oils, pigments, etc.

FI -1 WASTE TYRE RUBBER CHIPS

The scrap tyres are delivered to a processing plant as a whole, cut, or shredded tyres or buffing waste. CRM is produced using one or more combinations of the processes:

a. **Cracker Mill**

The most common method is the cracker mill process. The scrap tyres are pre-processed by shredding to remove steel cord and bead wire. Rotating corrugated steel drums are used to tear the scrap tyres into smaller ground CRM.

b. Granulator

In the granulator process, steel cord and bead wire are removed and close tolerance revolving steel plates are used to cut the scrap tyres into granulated CRM. The granulated CRM is cubical, uniformly shaped with a low surface area.

c. Cryogenic Process

In the cryogenic process, the pre-chipped scrap tyres are cooled with liquid nitrogen. The brittle tyre rubber is easily fractured with a hammer mill. The process uses a cooler to chill tile material, a grinder, appropriate screens and conveyors and steel and fiber separation systems. Usually, the cryogenic process is used as a preliminary step to the other processes which will reduce the particles to the desired size.

Crumb Rubber Modified Bitumen (CRMB)

Crumb rubber is also used to modify bitumen in an appropriate manner, so that its resistance to temperature, water etc is better. This modified bitumen is one of the important construction materials for flexible Road pavement. The rubber waste/crumb rubber modified bitumen show better properties for road construction.

Preparations to Make Crumb Rubber Modified Bitumen Blend

The studies on the behavior and binding property promoted a study on the preparation of rubber wastebitumen blend. It's bituminous properties are found. These properties are compared with Normal Bitumen. Then its suitability as a blend for road construction is investigated. Scrap tyre rubber can be incorporated into asphalt paving mixes using two different methods, which are referred to as the wet process and the dry process. In the wet process, crumb rubber acts as an asphalt cement modifier, while in the dry process, granulated or ground rubber and/or crumb rubber is used as a portion of the fine aggregate.

CRMB is produced by the so-called wet process in which crumb rubber is added to hot bitumen of temperature around 150 -160 degree C and the mixture is agitated mechanically until there is a “reaction” between the bitumen and crumb rubber. The “reaction” is not a chemical process but rather a diffusion process that includes the physical absorption of aromatic oils from the bitumen into the polymer chain of the rubber. The rubber particles swell as they absorb oils, which cause the viscosity of the CRMB to increase during the first hour or so. After the “reaction” and associated swelling is over the viscosity of the blend levels off.

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