FEASIBILITY STUDY OF DISCARDED FOOTWEAR USED TO ERADICATE POTHOLES: A REVIEW

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Abstract : Global warming is the most concerned topic nowadays. A large amount of bio-hazardous waste is created all over the world through discarding footwear. They get mixed with municipal solid waste or disposed over land area. So to reduce the various types of ill effects of solid waste created in million tones every year, we need to reuse the discarded footwear. In under developing countries where proper maintenance of road network is difficult due to lack of funds or heavy traffic better road infrastructure is required in less maintenance. In many investigations it has been found that strength of paving mixes can improved by adding various types of modifiers and agents with bitumen such as shredded rubber, polypropylene, Fly Ash etc. By use of such modifiers the viscosity characteristics and temperature susceptibility of bitumen are effectively improved and helped in improving certain problems such as bleeding of bitumen during summer season and stripping of aggregates in rainy season. The paper proposes an idea to develop a system to repair potholes using sustainable materials such as discarded footwear. It focuses on the current challenges with the existing technology to repair the potholes and how the proposed idea would be a boon to solve the present-day problem.

IndexTerms **- Discarded footwear, Reuse, Pothole, Sustainable materials, Bitumen.**

1. INTRODUCTION

A pothole is defined as "Distress observed in asphalt pavement from breakup of asphalt base course and majorly asphalt surface. Due to heavy traffic and action of various climatic conditions the pavement is weakened, leaving a pothole on road." Potholes are great disturbance to drivers having a potential for dangerous hazard on roadways. As a result of potholes every year 9,300 people are killed and about 25,000 are injured in road accidents in India.

According to a report in estimation it was found that annually 20 billion pairs of foot wears are manufactured and unfortunately around 20 million pairs are discarded. Manufacturing every pair of shoe or footwear involves 360 steps and about 30 pounds of carbon emissions. The shoe manufacturing process is a chemical intensive process. The contribution of various types of material in footwear waste in India is Leather (25%), Polyurethane (17%), Thermoplastic rubber (16%), Ethylene vinyl Acetate (14%), Poly Vinyl chloride(8%), Rubber(7%),Other material such as metals or adhesives(7%),Textile and fabrics(6%). A material Ethylene Vinyl Acetate commonly found in the sole of footwear lasts as long as 1000 years in landfill, whereas plastics are known to stay in landfill for 4500 years.

Our motivation of the current study is the abysmal state and the challenges faced by the municipal solid waste management and poor road infrastructure. Better infrastructure of road is required which requires less maintenance. India is second largest footwear producer and third largest footwear consumer in the world. If we compare to textile industry no major focus on work is done towards environmental sustainability in footwear industry. Land filling of such material is not considered the most desirable option because it has negative environmental impact, increasing landfill taxes, depletion of natural resources and limited availability of land. Incineration is also considered a controversial process with environmental concerns because of its polluting emission.

2. OBJECTIVE

2.1 To study the result of discarded footwear.
2.2 To understand the discarding rate of footwear by an individual.
2.3 To develop a road construction material from discarded footwear.
2.4 To analyse performance of discarded footwear used as road construction material.

3. LITERATURE REVIEW

Here are some research papers in which work has been done on use of plastic and rubber as road construction material.

3.1 Kalpana and D. Surendaran, Utilization of waste plastic in bituminous road, International Journal of pure and Applied Mathematics,Volume 119,No 17,2018,pp 1143-1156.

This study presents, adding plastic waste in mix will reduce the requirement of bitumen by almost 10%, this will improve the performance and strength of road, use of antistripping agent and disposal of plastic waste by incineration and land filling can be avoided and ultimately develops a technology. Plastic roads are means of preventing other adverse effects and hence will be the cure. It will save millions of rupees in future and reduce the use in amount of natural resources used for construction.

3.2 Tarangkumar tulsibai lakhani, Effectiveness of waste plastic in construction of bituminous road, International Journal of Advanced Engineering and research development, Volume 4, Issue 10, October 2017, pp 774-779

This paper presents information about waste plastic, material and methods, type of test conducted and its result. Plastic waste which consists of utilized plastic is used to coat aggregates and these coated aggregates can be utilized for constructing bituminous road. The plastic-coated aggregates having mix polymer coating showed higher strength.

3.3 G.Ramesh Kumar, S.Bharani, Partial replacement of bitumen by waste plastic and Polypropylene in road construction, Interational journal current engineering and Scientific research, Volume 4,Issue 11, 2017,pp 57-64.

This paper presents results of modified bitumen made by adding plastic waste in bitumen as a modifier by an amount of 1%, 3%, 5%, & 7% by weight of bitumen in bituminous mixture which is later used to fill potholes. When plastic waste is added with bitumen it shows increase in stability, water resistivity and capacity. Marshal stability test was done to stimulate with field condition. By carrying out experimental work it is concluded that the bitumen with waste plastic modifier can be used in warmer region for flexible pavement construction because of its stability and flow characteristic.

3.4 Bhadane Rupesh Umrao, Use of waste plastic and rubber crumb in construction of flexible pavement, International journal of Advance research, Ideas and Innovative Technology, Volume 5, 2019, pp 1951-1957.

This paper presents the test results of conventional bitumen and the crumb rubber and waste plastic modified bitumen which show that the penetration value and softening point can be significantly improved. The fire and flash point were also improved and the optimum percentage value for bituminous mix design and testing by replacing bitumen is taken as 10%. It can also be used to partially replace bitumen as well as can be coated over aggregates.

3.5 Rokade S. "Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements," in International Conference on Future Environment and Energy IPCBEE, Vol.28 (2012), IACSIT Press, Singapore, pp. 105-108.

The study shows use on Low Density Polyethylene (LDPE) and Crumb Rubber (CRMB) increased Marshall Stability value by 25%. By adding LDPE and CRMB in bitumen more durable and stable mix in obtained. Resistance to moisture and serviceability of roads is increased. This type of road is suitable for climatic conditions of India where the temperature in summer season is 50°C and heavy rains in rainy season causing heavy distress on roads.

3.6 Bhargavi Shah, (2018), To study the waste caused by discarded footwear in India and finding a solution for the reduction of the same.

This paper presents the idea of already existing solutions of footwear waste. At the end of the research prototype furniture (Shoe rack) is constructed using discarded footwear, which is also one of the solutions for waste minimization. The report also presents current situation of such type of waste management in India and condition of discarded footwear as well as challenges faced during recycling of mixed footwear.

3.7 R. Manju (2017), Use of plastic waste in Bituminous Pavement, International Journal of ChemTech Research, Vol 10, No. 8, 2017, PP 804-811.

This paper presents the use of plastic waste in bituminous pavement by comparing result of normal aggregate with plastic coated aggregate as well as tests are performed on simple bitumen and modified bitumen where modified bitumen is prepared by replacing bitumen by 10% After performing tests higher strength was observed in plastic coated aggregates and higher stability is observed in terms of bitumen.

3.8 Matthew Sainz, (2016), Pothole patching: A review on material and method

This paper presents, the potholes background, Types of technique to repair potholes or technique of patching, types of maintenance, cost required for repairing potholes, Performance after repairing potholes.

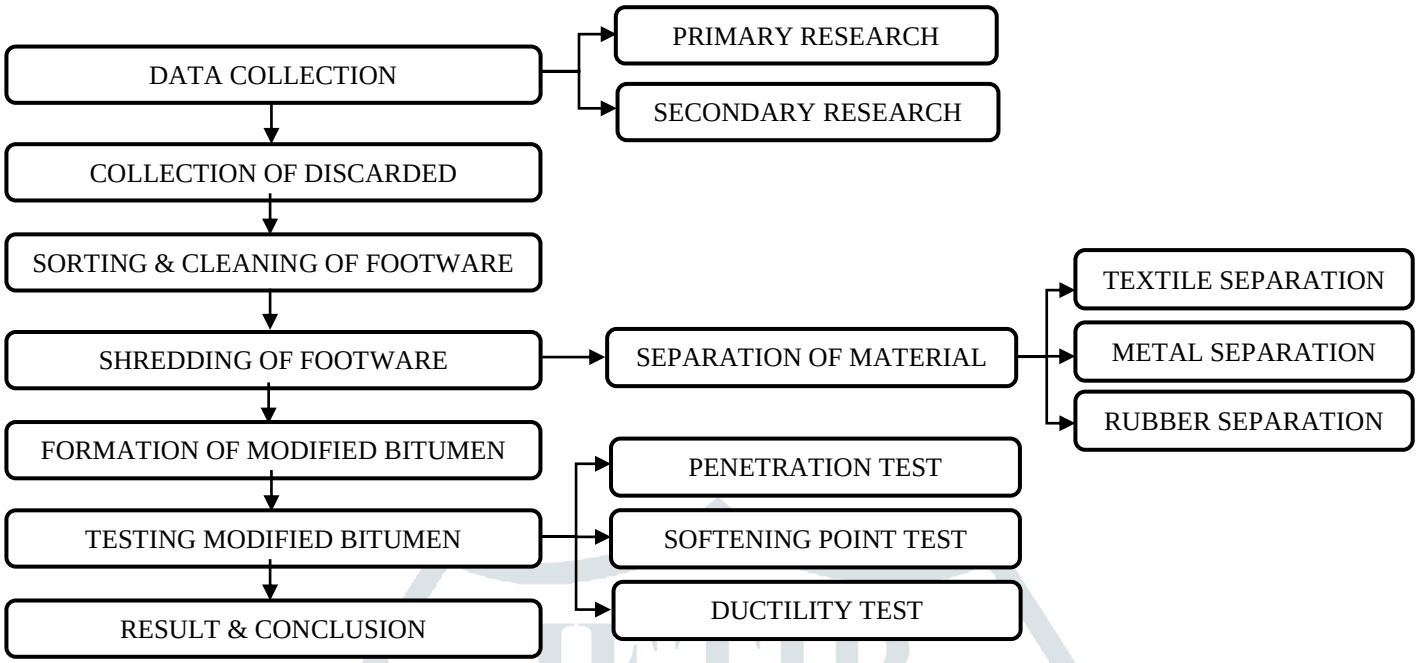
4. ADVANTAGES-

4.1 Replacement or reduced use of bitumen and use of sustainable material develops an eco-friendly technology.
4.2 Increase flexibility, flexural strength and withstand higher temperature. Plastic waste increases stability and reduces porosity.
4.3 Use of higher percentage of plastic and rubber from footwear.
4.4 Can increase employment among rag pickers as they get another work of sorting footwear and sending it to desired place thus improving economy.

5. DISADVANTAGES-

5.1 Toxins which are present plastic might start leaching.
5.2 Segregation of various footwear materials is difficult, and every material has different properties which need to be studied in great detail.

6. METHODOLOGY-



6.1 Data collection-

The research works starts with Data collection which comprises of primary research and secondary research where Secondary research was performed first where various papers and documents were studied related to reuse of footwear and waste such rubber and plastic. Primary research comprised of visiting local footwear manufacturers, carrying out survey at consumer level to study discarding rate of footwear, collecting discarded foot wears, looking companies who does shredding jobs.

6.2 Experimental work-

The process starts with collecting footwear and then sorting it according to requirement were rubber, plastic or footwear comprising this material along with other material is sorted. These footwears are then cleaned by de-dusting or washing if required and shredded into small pieces. Metal separation can be done after this. For material separation in case of textile, Air cascade can be used whereas for rubber, Air table can be used on larger scale. After this a bituminous mix needs to be prepared. For making bituminous mix used to fill potholes two important processes are used-

6.2.1 Dry process
6.2.2 Wet process

6.2.1 Dry process-

In this process the shredded footwear particles are poured over heated aggregates (170°C) to form aggregates which are coated with footwear material. These aggregates are then mixed with hot bitumen to form a mixture to fill potholes. After coating the aggregates with shredded footwear materials, the aggregate strength should be assessed by conducting tests on aggregate.

6.2.2 Wet process-

This method is commonly used where modified bitumen is to be formed. The shredded footwear materials are mixed directly with heated bitumen at 170 °C so a proper blend is formed. Here the ratio of adding shredded material can be changed and the best ratio of shredded footwear material to bitumen can be obtained by conducting various tests on bitumen such as penetration test, softening test etc. This modified bitumen is then mixed with aggregates to fill potholes and compacted with rod or roller.

7. EXPECTED OUTCOME-

7.1 Increased binding and Improvement in bonding of mix
7.2 Increased strength and durability of potholes.
7.3 It is economically sound and reduction in cost will be seen.

8. CONCLUSION

The paper proposes the idea of using sustainable materials for the repair of the potholes. According to the literature review referred we have come to the following conclusion that -

8.1 Use of waste plastic increases stability and reduces moisture absorption and Porosity. Plastic coated aggregates show increased bonding of mix, compressive strength, durability of road and soundness. It can also withstand higher temperature.

8.2 Use of rubber waste in form of crumb rubber by adding in bitumen- penetration, ductility, flash & fire point, softening point was decreased. Using of rubber coated aggregate in bituminous mix the flexibility of surface layers is modified which decreases noise pollution on heavy traffic roads. With all these advantages it is a good saving too.

8.3 Use of rubber waste and plastic waste as modifying agent in bitumen increases the Marshall Stability. More stable and durable bituminous mix is obtained which is suitable for climatic conditions of India.

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