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RUBBER WASTE AND ITS USE IN THE CONSTRUCTION INDUSTRY: A SYSTEMATIC STUDY

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ABSTRACT

Municipal solid trash is being produced at an accelerated rate due to factors such as an increasing population, more urbanisation, and industrialization. The necessity to environmentally friendly revamp current waste management practices is critical in light of the increasing volume of solid waste in modern society. Urban and rural regions alike have seen a rise in solid waste production due to the confluence of a growing population and better living standards. While most urban solid trash, including plastics and packaging, does not biodegrade, rural solid waste is naturally quite biodegradable. That dislike of temperament is prevalent in both domains. Similar to other industries, India's solid waste management system distinguishes between urban and rural areas. Urban solid waste typically includes non-biodegradable materials like plastics and packaging, in contrast to biodegradable solid garbage from rural areas. The fraction of solid waste that cannot be biodegraded is utilised in an integrated closed-loop refinery platform to create products with additional value. Rock waste (SW), fly ash (FA), palm oil fuel ash (POFA), rubber waste (RW), wood flour (WP), plastic waste (PW), and rice husks are the materials that are the centre of the emphasis of the investigation. Random Household Ash (RH) and Municipal Solid Waste Ash (MSWA) are being considered for usage as partial concrete replacements. Reducing landfill problems, saving energy, and mitigating global warming are all outcomes of recycling non-biodegradable trash and utilising it in construction for a number of uses. We recycle it and put it to sustainable use in our company to cut down on this non-biodegradable trash.

Keywords: Rubber Waste, SW, FA, POFA, MSWA RW, WP, PW, urban solid waste, rubber waste management

INTRODUCTION

Rubber waste refers to discarded or unwanted rubber materials that have reached the end of their useful life. Rubber is a versatile material used in various products, including tires, footwear, industrial goods, and consumer products. The disposal of rubber waste poses environmental challenges due to its non-biodegradable nature and potential negative impacts on ecosystems. At this point in time, civilization is confronted with issues that are associated with the adoption of principles of sustainable development in each and every department of the economy. According to Sienkiewicz et al. (2017), the problem of the sustainable development paradigm is not only focused on reducing the consumption of non-renewable resources from the environment, but it also focuses on extending the "life-cycle" of the product by making use of recycled raw materials. As a result, it also establishes specific requirements for the waste management phase.

According to Thomas and Gupta (2016), the challenge of handling waste rubber is becoming increasingly essential. This is owing to the fact that the global manufacturing of these items is increasing at a rapid rate. It was estimated that 2.68 million tonnes of rubber products and 4.89 million tonnes of rubber tyres were manufactured all over the world in the year 2015. At the end of 2017, the output of rubber products reached 2.70 million tonnes, which is a 2% rise over the previous year. Additionally, 4.94 million tonnes of automobile tyres were manufactured, which is equivalent to a 1% increase in production. In the process of assessing the past years, it is important to notice that the trend of production growth of rubber products and automobile tyres is not a consistent trend. However, due to the scale of production, the management of rubber waste is a difficulty for the current civilization. Based on the assumption that the lifespan of automobile tyres is between four and six years (according to the United States Department of Transportation, 2007), it is possible to evaluate the possibility that after this amount of time, they would be deemed waste. It is important to note that around 20–25% of the weight of a tyre reduces while it is being used (Wojciechowski et al., 2012). Additionally, it is important to note that only a small portion of automobile tyres 20 will be recycled in the form of re-treading (in Poland, approximately 20% (www.opony.com.pl)), and the remaining tyres will be returned to the use phase.

A total of 3.19 million tonnes of waste rubber was produced in the European Union in the year 2014, and 3.37 million tonnes of trash rubber was produced in the year 2016. According to Eurostat, the amount of waste rubber produced in Poland during these years was 0.063 million tonnes and 0.081 tonnes, respectively.

As a result of the magnitude of the situation, the search for appropriate and sustainable waste management systems is of utmost significance for the purpose of protecting the environment. Because of their abundance and longevity, used automobile tyres have been classified as a nuisance waste. Furthermore, they do not decompose in the environment even after a hundred years have passed (Gronowicz, Kubiak, 2007).

The article that follows provides an overview of various approaches to the management of rubber waste, with a specific focus on thermolysis, which is an example of a new approach to the disposal of rubber waste. This mobility is the primary factor that contributes to the innovative nature of the newly planned and manufactured thermolytic installation that was created by GMG. The objective of this article is to examine several approaches to the disposal of rubber waste, shedding light on the benefits and drawbacks associated with each of these approaches, including the recently developed thermolytic installation.

Figure 1: Fine and coarse waste rubber tire crumbs (WRTCs) preparation process (**Sources:** Mhaya, A.M. *et al* 2021)

The process of breakdown is extremely sluggish because the product is made from components that are incompressible and non-biodegradable. The aqua silencer works by forcing the exhaust gas into a septic tank that contains an alkaline solution. This is the basic idea of the device. Under these conditions, the temperature of the gas is decreased, and the majority of the nitrogen oxides that are present in the exhaust gas are eliminated.

Utilising burning tyres was one of the earliest scrapping tactics. Because this was the most straightforward and economical method. On the other hand, this alternative has a number of adverse impacts on both the health of humans and the environment, and it also presents a risk of fire. Once a fire has been started in a tyre inventory, it is quite challenging to put it out because of all the open space that surrounds each tyre.

The tyre supplies an adequate amount of oxygen, which allows the combustion process to continue for a longer period of time. As a result of the combustion process, emissions are produced that contain components that have the potential to be hazardous to human health. These pollutants include polyaromatic hydrocarbons, carbon monoxide, sulphur dioxide, nitrogen dioxide, hydrogen chloride, butadiene, and various styrenic and benzene compounds. In addition to this, it results in the random release of materials. The objective of this study is to evaluate the effects that replacing the volume of coarse aggregate in PCC samples with fine-grained rubber has on the impact loading performance of concrete and to compare the results with those obtained from regular PCC samples. For the purpose of determining the strength properties, it is necessary to conduct tests on concrete beams that have been designed with a concrete combination of the M20 grade. For volumetric displacement of coarse grains, beam samples should be made for 5, 10, 15, and 20% of the total volume required. It is necessary to conduct tests on the specimen to determine its impact, compression, and tensile properties for each of these scenarios.

Solution to Scrap Rubber

The incorporation of rubber into concrete results in the production of a new type of concrete that possesses distinctive mechanical qualities and enhanced resistance to impact. Rubber aggregates have been demonstrated to improve ductility, elongation capacity, impact strength, and energy absorption in the majority of the prior research that have been conducted on the use of chopped and/or brittle rubber as alternatives for coarse and/or fine aggregates. According to the paper, it has the potential to be an alternate method that may be used to improve concrete. There are further advantages of employing leftover rubber in the making of concrete, which are stated below.

Benefits from Scrap Rubber

The amount of solid trash that is produced is dramatically rising on a daily basis as a result of the rapid rise of the population and the urbanisation of the world. Due to the increasing expansion of the automotive industry, waste rubber tyres constitute the majority of solid waste, which makes the disposal of these tyres a subject of significant concern. Waste rubber tyres are a global problem because of their chemical makeup, the fact that they are combustible, and the fact that they do not biodegrade. When anything is burned, harmful gases are released into the atmosphere, which pollutes the air and poses a risk to human health. In the event that items are kept in landfills for extended periods of time, harmful compounds have the potential to seep into the ground and contaminate the groundwater. Moreover, stored tyres serve as a breeding ground for mosquitoes and other pests that are capable of transmitting bacteria and viruses. The disposal of these will invariably result in the disposal of landfills.

Disadvantages

The problem can be effectively addressed by recycling and reusing scrap rubber tyres, which is an ideal solution. There is a significant amount of research being conducted in the field of recycling scrap tyres. It is therefore possible to recycle discarded rubber by employing it in the production of concrete. This reuse also makes it easier to design environmentally friendly buildings and promotes the idea of sustainable production, which has recently garnered a lot of attention. Additionally, due to the fact that rubber aggregate has a lower density than traditional aggregate, it has the potential to make a significant contribution to the creation of semi-lightweight and lightweight concrete, which in turn contributes to construction that is more cost-effective.

Rubber, which can be used as an alternative to aggregate, is a step towards sustainability because it contributes to the preservation of expensive natural resources for the benefit of future generations. It also offers a remedy to the complete shortage that has been brought about by limits imposed by environmental laws. Nevertheless, this reuse does not come without a few problematic aspects.

The mechanical properties of concrete, including its compressive strength, split tensile strength, flexural strength, and modulus of elasticity, are negatively impacted when the amount of rubber in the concrete component is increased. According to the findings of certain investigations, this reduction could have been caused by two different situations.

1. The fact that rubber aggregate has a lower elastic modulus in comparison to cement paste that has been hardened
2. Insufficient adhesion between the rubber particles and the cement that surrounds them.

Each year, more and more products made of rubber are being utilised all over the world. Additionally, India is one of the countries that uses rubber products to the greatest extent. Rubber can be broken down in the simplest and most cost-effective manner by burning it. This results in pollution from smoke, various emissions of hazardous substances, and warming of the planet. At the moment, between seventy-five and eighty percent of worn tyres are disposed of in landfills. There is a utilisation of less than 25 percent as a fuel replacement or raw material for a variety of rubber products. Not only is it a wasteful practice to bury discarded tyres in landfills, but it is also an expensive one. The majority of landfill operations do not allow the disposal of complete tyres because of their propensity to float to the surface if there is a fire of sufficient size and duration. Therefore, in order for tyres to be permitted in the majority of landfills, they must first be completely shredded. Rubber tyres are put through a variety of recycling procedures in this manner, depending on the requirements. At this point, one of the operations that transforms tyre rubber into crumb rubber is being carried out. Numerous undertakings, including the construction of roads and the production of moulds, make use of it.

Here are some common sources of rubber waste and ways to manage or recycle it:

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- Tires:

Recycling: Used tires can be recycled into various products, such as playground surfaces, athletic tracks, rubberized asphalt, and even new tires.

Shredding: Tires can be shredded to create tire-derived aggregate, which is used in civil engineering applications like road construction.

- *Industrial Rubber Waste*:

Reclamation: Some industrial processes generate rubber waste, which can be reclaimed and reused in manufacturing processes.

Recycling: Rubber from industrial processes can be recycled into new products.

- *Consumer Products*:

Recycling: Certain rubber products, such as shoes and electronic devices, can be recycled. However, this may be more challenging than recycling larger items like tires.

- *Rubber Packaging*:

Reduction: Minimizing the use of rubber packaging or opting for eco-friendly alternatives can help reduce rubber waste in the first place.

- *Landfill Disposal:*

Challenges: Rubber does not decompose easily, so disposing of it in landfills can lead to long-term environmental issues.

- *Energy Recovery:*

Incineration: In some cases, rubber waste can be burned for energy recovery, but this process has environmental concerns, such as emissions.

- *Research and Innovation:*

Investment: Supporting research and innovation in rubber recycling technologies can lead to more sustainable solutions for managing rubber waste.

Efforts to address rubber waste often involve a combination of recycling, reusing, and reducing consumption. The development of new technologies and the promotion of sustainable practices are crucial in managing and mitigating the environmental impact of rubber waste. Additionally, public awareness and participation in recycling programs contribute to the overall success of waste management efforts. Pulverisation at room temperature, low temperature, and wet or solution pulverisation are now the most used processes for making waste rubber powder in China (Fig.2)

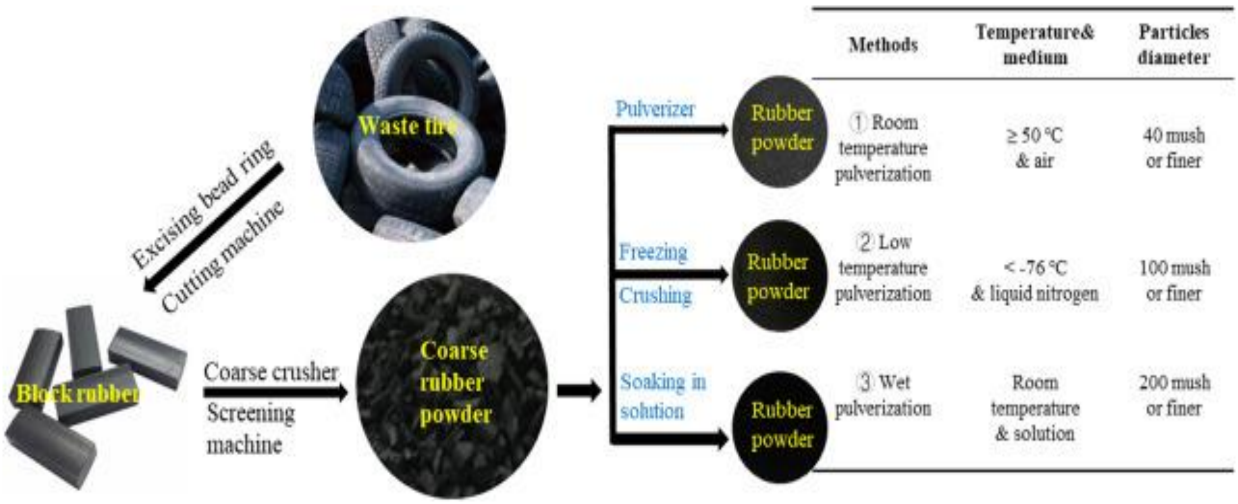

Figure 2: Most used processes for making waste rubber powder in China (Sources: Serji Amirkhanian et al., 2021)

Rubber waste, such as discarded tires and other rubber products, can be recycled and repurposed for various applications in the construction field. This not only helps in waste management but also contributes to sustainable and environmentally friendly construction practices. Here are some applications of rubber waste in construction:

1. Rubberized Asphalt: One of the most common uses of recycled rubber in construction is in the production of rubberized asphalt. Rubber crumbs from old tires can be mixed with asphalt to create a flexible and durable road surface. This not only enhances the road's performance but also provides a sustainable solution for disposing of used tires.

2. Rubber Mulch: Ground rubber from tires can be used as a mulching material in landscaping and playgrounds. It provides a cushioning effect, reducing the impact of falls, and also acts as an effective weed barrier. Rubber mulch is durable and does not decompose like traditional organic mulches.

3. Construction Mats: Rubber waste can be converted into construction mats, which are used to create temporary roadways and pathways in construction sites. These mats are durable, provide traction, and protect the underlying soil from heavy equipment, minimizing environmental impact.

4. Noise Barriers: Rubber sheets or panels made from recycled rubber can be used as noise barriers along highways or construction sites. The flexibility and density of rubber help in absorbing sound, reducing noise pollution in surrounding areas.

5. Anti-Vibration Pads: Rubber waste can be utilized in the production of anti-vibration pads. These pads are used to reduce vibrations and noise in buildings, machinery, and equipment. They find applications in various construction scenarios where damping vibrations is crucial.

6. Building Insulation: Rubber can be processed into sheets or granules to create insulation materials. Rubber insulation provides thermal and acoustic insulation in buildings, contributing to energy efficiency and creating a more comfortable indoor environment.

7. Concrete Additive: Ground rubber can be used as an additive in concrete to improve its properties. Rubberized concrete is lighter and more flexible than traditional concrete, making it suitable for applications where weight and flexibility are important factors.

8. Landfill Construction: Rubber waste can be used in landfill construction to create a stable and permeable base. The flexibility of rubber helps to absorb and distribute loads, reducing the risk of damage to the landfill liner.

9. Artificial Turf Infill: Rubber granules from recycled tires are commonly used as infill material in artificial turf systems. This provides cushioning, improves shock absorption, and enhances the performance of the artificial turf.

10. Erosion Control: Rubber products, such as shredded tires, can be used in erosion control applications. They help prevent soil erosion by stabilizing slopes and providing a protective layer against water runoff.

By incorporating rubber waste into construction projects, builders can contribute to sustainable practices, reduce the environmental impact of waste, and create innovative solutions for various construction challenges.

CONCLUSION

Municipal solid trash is being produced at an accelerated rate due to factors such as an increasing population, more urbanisation, and industrialization. The necessity to environmentally friendly revamp current waste management practices is critical in light of the increasing volume of solid waste in modern society. Urban and rural regions alike have seen a rise in solid waste production due to the confluence of a growing population and better living standards. While most urban solid trash, including plastics and packaging, does not biodegrade, rural solid waste is naturally quite biodegradable. That dislike of temperament is prevalent in both domains. Similar to other industries, India's solid waste management system distinguishes between urban and rural areas. Urban solid waste typically includes non-biodegradable materials like plastics and packaging, in contrast to biodegradable solid garbage from rural areas. The fraction of solid waste that cannot be biodegraded is utilised in an integrated closed-loop refinery platform to create products with additional value. Rock waste (SW), fly ash (FA), palm oil fuel ash (POFA), rubber waste (RW), wood flour (WP), plastic waste (PW), and rice husks are the materials that are the centre of the emphasis of the investigation. Random Household Ash (RH) and Municipal Solid Waste Ash (MSWA) are being considered for usage as partial concrete replacements. Reducing landfill problems, saving energy, and mitigating global warming are all outcomes of recycling non-biodegradable trash and utilising it in construction for a number of uses.

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