CASE STUDY OPEN ACCESS

A REVIEW OF THE APPLICATIONS OF RUBBER WASTE IN CONSTRUCTION FIELD

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Abstract:

Population growth, rapid urbanization and industrialization are accelerating the generation of municipal solid waste. Solid waste disposal is a fast-growing problem today, and there is an urgent need to transform existing disposal processes in a sustainable way. The combination of population explosion and improvement in people's lifestyles has led to an increase in solid waste generation in both urban and rural areas of the country. Solid waste from rural areas is inherently highly biodegradable, while solid waste from urban areas contains many non-biodegradable components such as plastics and packaging. That aversion to disposition is common in both fields. In India, as in all other sectors, there is a clear distinction between urban and rural solid waste. Solid waste from rural areas is likely to be biodegradable, while solid waste from urban areas contains non-biodegradable components such as plastics and packaging. Non-biodegradable solid waste fraction in an integrated closed-loop refinery platform for the production of value-added products. The research focuses on recycling materials such as rock waste (SW), fly ash (FA), palm oil fuel ash (POFA), rubber waste (RW), wood flour (WP), plastic waste (PW) and rice husks. Considered for use. (RH), and Municipal Waste Ash (MSWA) for partial replacement of concrete. Recycling non-biodegradable waste and using it in construction for a variety of purposes not only reduces landfill problems, but also contributes to energy savings and global climate change mitigation. To reduce this non-biodegradable waste, we recycle it and use it sustainably in our industry.

***Keywords* — :** Biodegredable, Municipal solid waste, Palm oil fuel ash, Rubber waste.

I. INTRODUCTION

Manufactured from incompressible, non-biodegradable materials, the degradation process is very slow. The principle of the aqua silencer is to blow the exhaust gas into a septic tank with an alkaline solution. Here, the temperature of the gas is lowered while most of the nitrogen oxides in the exhaust gas are removed.

Early scrapping strategies included burning tires. Because this was the easiest and cheapest way. However, this option has many negative effects on the environment and human health, and also poses a fire hazard. Extinguishing a tire inventory fire once ignited is very difficult because all the free space around each tire provides enough oxygen to prolong the combustion process. The combustion process produces emissions containing potentially harmful substances such as polyaromatic hydrocarbons, carbon monoxide, sulfur dioxide, nitrogen dioxide, hydrogen chloride, butadiene, and other styrenic and benzene compounds that pose a hazard to human health. It also leads to uncontrolled release of matter. The purpose is to investigate the effect of volume replacement of coarse aggregate of PCC samples by fine-grained rubber on the impact loading performance of concrete and to compare the results with those of regular PCC samples. To determine the strength properties, tests should be carried out on concrete beams designed with a concrete mixture of grade M20. Beam samples should be prepared for 5, 10, 15 and 20% volumetric displacement of coarse grains. For each of these cases, the specimen should be tested for impact, compression, and tensile properties.

SCOPE OF THE WORK

The use of rubber products is increasing year by year worldwide. India is also one of the largest countries using rubber products. The easiest and cheapest way to break down rubber is to burn it. This leads to smoke pollution, other toxic emissions and global warming. Currently, 75-80% of used tires end up in landfills. Less than 25% is used as a fuel substitute or raw material for various rubber products. Burying used tires in landfills is not only wasteful, it's also expensive. The disposal of whole tires is prohibited in most landfill operations due to their tendency to float to the surface with fire size and time. As a result, tires must be shredded before they can be accepted in most landfills. In this way, rubber tires are subjected to many recycling processes as needed. From here, one of the processes of processing tire rubber into crumb rubber. It is used in many works such as road construction and mold making.

II. SCRAP RUBBER – A SOLUTION

Incorporating rubber into concrete creates a new type of concrete with unique mechanical properties and improved impact resistance. Most of the previous studies on the use of chopped and/or brittle rubber as substitutes for coarse and/or fine aggregates have shown that the use of rubber aggregates improves ductility, elongation capacity, impact strength and energy absorption. It reports that it can be a potential alternative method to improve. of concrete. Other benefits of using waste rubber in concrete production are listed below.

Advantages

Due to rapid population growth and urbanization, the amount of solid waste generated is increasing significantly every day. With the rapid growth of the automotive industry, waste rubber tires make up the majority of solid waste, making its disposal a major concern. Waste rubber tires are a global problem due to their non-biodegradable, flammable and chemical composition. Burning releases toxic gases that pollute the air and are a health hazard. If these are stored in landfills for long periods of time, toxic substances can leach into the soil and contaminate groundwater. Stored tires also become a breeding ground for mosquitoes and other pests that can spread disease. Landfilling these will inevitably lead to landfilling.

Recycling and reuse of waste rubber tires is an effective way to solve this challenge. There is a lot of research going on in the recycling of tire waste. So using waste rubber in making concrete is also a way to recycle it. This reuse also facilitates the development of green buildings and promotes the concept of sustainable production, which has recently received much attention. In addition, since rubber aggregate has a lower density than conventional aggregate, it can greatly contribute to the development of semi-lightweight and lightweight concrete, contributing to more economical construction.

Used as a substitute for aggregate, rubber is a step towards sustainability by helping to conserve precious natural resources for future generations. It also provides a solution to the total shortage due to environmental policy restrictions. However, this reuse is not without certain drawbacks.

Disadvantages

Increased rubber content adversely affects concrete mechanical properties such as compressive strength, split tensile strength, flexural strength and modulus of elasticity. There are two possible reasons for this decline, according to certain studies.

1. Low elastic modulus of rubber aggregate compared with hardened cement paste

2. Poor adhesion between rubber particles and surrounding mortar.

Use Of High-Density Polyethylene (HDPE)

Numerous studies continue to improve the properties of crumb rubber concrete by compensating for its loss of strength. We recommend pre-treating the rubber with our materials. Several studies have shown that adding HDPE or polypropylene fibers significantly improves properties such as compressive strength. The purpose of this study is to incorporate HDPE into rubber concrete and find the optimum ratio of these components to maximize their properties.

MATERIALS AND METHODS

Tire derived aggregate Made from shredded scrap tires. Used in a wide range of construction projects. There are different size TDA aggregates:

- Small (1mm - 3mm)
- Medium (2mm – 4mm)
- Large (8mm – 15mm)

TDA AGGREGATE

Three different sizes of TDA aggregate were collected from a tire recycling company in Victoria, Australia. A nominal 20mm RCA was collected from a demolition recycling site in Victoria. Small size TDA (TDA-S) ranges from 1 mm to 3 mm, medium size aggregate 9 (TDA-M) ranges from 2 mm to 4 mm, large size aggregate (TDA-L) 8 ranged from mm to 15 mm. . Shows variations in TDA size. A series of laboratory tests were conducted to characterize the suitability of RCA-TDA blends for pavement/subgrade applications. Geotechnical laboratory tests performed included grain size distribution, pH, plasticity index, organic content, Los Angeles (LA) abrasion, grain density, water absorption, flaky index, modified compaction, California bearing ratio (CBR), seepage modulus, permanent set, and cyclic load triaxial (RLT) testing. Samples collected from the recycling site were dried in an oven and then thoroughly mixed to minimize separation and sample-to-sample variability. By adding TDA to RCA at 1%, 2%, and 3% by weight, and mixing, he made quarter subsamples and performed laboratory tests. Sieve analysis was performed for both TDA and RCA by washing. At least 3 kg were washed through a 75 mm sieve and the particle size distribution was determined on the remainder dried in the oven. RCA fines (75mm and above) were tested to determine plasticity according to the Australian Standard (2009c) and found the material to be non-plastic. The particle densities of the agglomerates were separated into a fine fraction (passed through a 4.75 mm sieve) and a coarse fraction (retained on a 4.75 mm sieve) according to Australian Standard (2000b) and (Australian Standard, 2000a), respectively. Aggregates were classified as scaly if the particle thickness (smallest dimension) was less than 60% of the average sieve size. The presence of flaky aggregates can reduce compressibility and reduce the overall strength of the material, but most TDAs and RCAs are classified as bulky. Los Angeles Los Angeles The Los Angeles Degradation Test has been widely used as an indicator of the relative quality or suitability of different aggregate sources with similar mineral composition. Abrasion tests were conducted in Los Angeles. Given the complex interaction between hard concrete particles and soft tire aggregates, modified compression tests were performed on all RCA-TDA mixtures to determine maximum dry density (MDD) and optimum moisture content (OMC) Did. The sample was compressed in 5 layers in a mold with a diameter of 105 mm and a height of 120 mm. Each layer was scored before compressing the next layer to create interlocking and minimize the potential for horizontal cracking during sample transfer. The permeability of the compressed mixture was measured in a 150 mm diameter mold using the drop head method with the RLT test performed according to the Aust-Straßen Triaxial Repeated Load Test Method. The sample was compressed into 8 layers in a 105 mm diameter and 200 mm high mold using the same energy used for the modified compression to achieve the targeted MDD. Samples were dried to 90% and 70% OMC in a closed chamber prior to testing. The sample was then wrapped in a plastic seal and left at room temperature for 24 h to equilibrate the moisture between the core and surface of the sample. However, granular materials that produce slightly higher creep limits are also acceptable, especially at moisture levels in the 80%, 90% OMC range, when high modulus values are achieved. The RLT test method consists of a permanent set test followed by a modulus test. Permanent set determination characterizes the vertical permanent set at multiple loading stages (at different loading conditions) to allow quantification of the effect of normal stress on permanent set in a single test. A limiting stress of 50 kPa and three different stress levels (at the specified deflection stress) were used for all blends. Each load level in the permanent deformation test program consisted of 10,000 repetitions. Young's modulus determinations characterize the vertical elastic strain response over 60 loading conditions using a combination of dynamic vertical and static lateral loads applied in the ranges of 100–500 kPa and 20–150 kPa, respectively. increase. Each load case consists of 200 load cycles. The small size increases the stress and stress ratio to avoid premature failure that can occur if the stress ratio is high.

IV.1 DISPOSAL OF NON BIO DEGRADABLE SOLID WASTE

A non-biodegradable material is a substance that cannot be fragmented down by microorganisms or natural organisms and is a major source of pollution. Non-biodegradable wastes neither get decomposed nor dissolved by natural agents. Various researches on recycled materials from non- biodegradable solid wastes and their applications are mentioned. These wastes continue to remain on earth for centuries without any degradation. Thus, the threat, which is caused by these wastes, is far more critical than the biodegradable waste. Moreover, these wastes cannot be decomposed and often get accumulated to make the biological cycles slow and toxic. There are two types of non-biodegradable wastes, which can be recycled known as “Recyclable waste” and which can't be recycled known as "Non-recyclable waste". There is an urgent need to increase the amount of waste that can be recycled and reused especially, in the construction industry. This will not only generate a potential business opportunity but also employment generation and environmental sustainability.

IV.2. REUSING

Reuse is an unused or a waste product without many transformations and also without altering its shape and originality. Reuse means that a lesser amount of solid waste is produced. These waste products, which are discarded, can be used by those who require it. Various types of solid wastes that can be reused in construction activities are plastic, timber, glass, concrete and ferrous as well as non-ferrous metals. Reuse of plastic can help in plastic - soil paver blocks for no-load bearing structures and the timber products help in providing a framework and be reused several times. Glass helps in the production of construction activities such as tiles, bricks and paver blocks and can be reused. Concrete from construction and demolished sites can be reused as temporarywork. Ferrous and non-ferrous metals are used for the formwork of metals and can be used several times

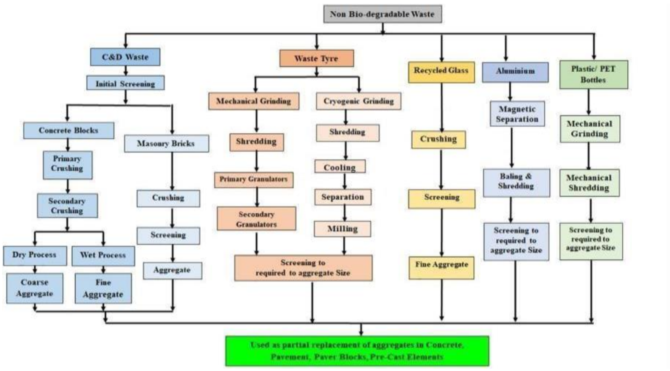

FIG.1 APPLICATION OF NON BIODEGRADABLE WASTE

IV.3. RECYCLING

Waste recycling is the reprocessing of waste so that it can be used to manufacture new products. This reprocessing also has impacts on the environment and human health, but these impacts are typically smaller than those caused by manufacturing new products from raw or new materials. Recycling can therefore also be defined as viewing materials as valuable resources rather than waste. Using this waste in construction solves this problem, as it is very cheap compared to new.

IV.4. CONSTRUCTION AND DEMOLITION WASTE

Nevertheless, it is difficult to enumerate potential material savings from recycling construction waste in the Indian context. Construction and demolition waste accounted for 36% of silt, sand and gravel, 31% of bricks and masonry, 23% of concrete, 5% of metal and 5% of others. Recycling of C&D waste begins with sorting unwanted materials such as plastic, wood and metal scraps. (equivalent to 10% of total waste). Much of the waste generated is stone and concrete that can be used as recycled aggregate for concrete. When added to concrete mixes, RCA lightens concrete and increases strength and durability by up to 30% compared to natural aggregate concrete mixes.

IV.5 CRUMB RUBBER FROMWASTE TYRE

Incorporating waste such as recycled tires into concrete mixes can directly reduce costs and have a quantifiable impact on the environmental lifecycle compared to conventional concrete. The economic benefits of recycled aggregate (recycled scrap tires) when added to concrete are not achieved through direct cost. This is achieved by shortening the distance between source and placement, making it easily accessible to the nearby construction industry. Concrete mixes can be made by mixing a base mix with rubber powder or rubber crumbs made from composite materials that improve strength and durability. Rubber is a superelastic material. This improves the internal structure of the concrete without changing its chemical properties and provides physical effects to the concrete. The modulus of elasticity of rubber is considered almost negligible compared to concrete. For this reason, the addition of rubber particles is considered elastic porosity, which prevents the formation of microcracks and improves the ductility of concrete. It also helps improve the frost resistance of concrete and its resistance to chloride ion migration.

III. CONCLUSION & OBSERVATIONS

The impact strength of concrete increases with increasing rubber grain content. Rubber substitute concrete can be used in lightweight concrete as it reduces the density of the concrete. The process of adding rubber granules to concrete is a better solution for its disposal, an environmentally friendly hard paving construction method. The compressive strength of concrete decreases with increased rubber waste replacement. The tensile strength of concrete increases with increasing rubber content. Since rubber tires are a significant solid waste, this is an effective disposal method. Literature review and experimental studies conclude that the demand for concrete, which can be used as a partial replacement, is very high despite the decline in strength of concrete. India has almost no tire recycling industry despite having 36 tire manufacturers. Therefore, it is necessary to expand the tire recycling industry. Lightweight rubber concrete can be used for architectural purposes.

REFERENCES

1.Paulo Roberto Lopes Lima, Monica Batista Leite, Ediela Quinteiro RiberioSantiago,"Recycled lightweight concrete made from footwear industry waste and CDW " Waste Management 30(2010) 1107-1113.

2. **G. Velvizhi, S.Shanthakumar, Bhaskar Das, A. Pugazhendhi, T.Shanmuga Priya, B.Ashok K.Nanthagopal, R.Vignesh, C.Karthick**,"Biodegradable and non- biodegradable fraction of municipal solid waste for multifaceted applications through a closed loop integrated refinery platform : Paving a path towards circular economy" Science of the Total Environment 731 (2020) 138-49.

3. **Arul Arulrajah, Alireza Mohammadinia, Suksum Horpibuisuk**, "The derived aggregates as a supplementary material with recycled demolition concrete for pavement application "Journal of cleaner production 230 (2019) 129-136.

4. **Toutanji, H.A**., 1996. The use of rubber tire particles in concrete to replace mineral aggregates. *Cement and Concrete Composites*, *18*(2), pp.135-139.

5. **RedaTaha, M.M. El-Dieb, A.S. Abd El-Wahab, M.A. and Abdel-Hameed, M.E**., 2008. Mechanical, fracture, and microstructural investigations of rubber concrete. *Journal of materials in civil engineering*, *20*(10), pp.640-649.

6. **Wang, C., Zhang, Y. and Ma A**., 2010. Investigation into the fatigue damage process of rubberized concrete and plain concrete by AE analysis. *Journal of Materials in Civil Engineering*, *23*(7), pp.953-960.

7. **Naito, C., States, J., Jackson, C. and Bewick, B**., 2013. Crumb Rubber Concrete Performance under Near-Field Blast and Ballistic Demands. *Journal of Materials in Civil Engineering*, *26*(9), pp. 401-462.