SUSTAINABLE UPGRADING OF CONCRETE PAVERBLOCKS USING WASTE TYRE RUBBER

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ABSTRACT

The Aim of our research work is to report on an experimental study that explores the effect of using recycled rubber powder as an alternate fine aggregate in concrete mixes. Natural sandin the concrete mixes was partially replaced by 5%, 10%, 15%, and 20%. Physical properties such as the density, the compressive strength, the fresh concrete properties, the split-tension, and the impact load capacity are examined. The results revealed a decrease in the compressive strength of concrete cylinders containing rubber. The dynamic performance ofthe rubber concrete is of high importance because of its high resilient nature, as the rubber particles that are included in the concrete have a positive effect on the dynamic performance. The conclusions that were derived from this research implicate potential applications where rubberized concrete can be efficiently used. Even though rubberized concrete mixture generally has a reduced compressive strength that may limit its use in certain structural applications, it possesses a number of desirable properties, such as key work, Paver block, Waste tyre rubber, and higher impact resistance compared to conventional concrete.

INTRODUCTION

In developing nations, the widespread utilization of concrete blocks as paving material is common. Cement and aggregate, which are crucial components in concrete block production, are also essential materials in the construction industry. This has resulted in the depletion of natural resources, such as aggregate, due to quarrying for concrete block manufacturing. Consequently, there is a growing concern for environmental protection and a need to conserve natural resources. To address these issues, alternative materials like recycled or waste tyre materials are being explored. However, the increasing disposal of waste tyres worldwide poses a significant challenge. Waste rubber is not easily biodegradable, even after long periods of landfill treatment, leading to the accumulation of discarded waste tyres and environmental issues. Existing concrete is typically characterized by high compressive strength, moderate tensile strength, and low toughness. Ideally, concrete blocks for pavement construction should possess high tensile strength and toughness. However, it is challenging to develop concrete with both high strength and high toughness without modifications. The high toughness of waste tires suggests that incorporating crumb rubber into concrete mixtures can significantly enhance the concrete's toughness. Laboratory tests have shown that the additionof waste tire rubber considerably improves the toughness, impact resistance, and plastic deformation of concrete, making it suitable for applications in sound/crash barriers, retaining structures, and pavement structures. Unfortunately, limited attention has been given to the use of waste tires in Portland cement concrete mixtures, especially for highway applications. Some researchers have investigated the potential use of rubber tires in concrete paving block mixtures, but more comprehensive studies are needed to understand the basic engineering properties. The use of rubber products is increasing globally, including in countries like India with a population exceeding 100 crores. As vehicle usage increases, so does the accumulation of waste tire rubber. This presents a major problem for the environment. The most commonand cost-effective method of disposing of rubber waste is burning, which contributes to smoke pollution, toxic emissions, and global warming. Currently, around 75-80% of scraptires are buried in landfills, while only a small percentage is utilized as fuel or raw materialfor various rubber goods. The burial of whole tires in landfills is both wasteful and expensive. Due to their bulkiness and tendency to float, tire disposal in landfills has been mostly banned. Therefore, tires need to be shredded before being accepted in most landfills. Various recycling methods, including the production of crumb rubber, are employed to address this issue. Crumb rubber finds application in road construction and other sectors.

OBJECTIVES

1. To examine the characteristics of concrete after substituting waste tyre rubber.
2. To assess the fresh and hardened properties of concrete produced by replacingconventional ingredients with recycled rubber.
3. To explore the optimal mix proportion of rubberized concrete and evaluate itsproperties.
4. To compare the compressive strength of conventional concrete blocks with rubberizedconcrete blocks.

METHODOLOGY

Flow-chart

Material Selection

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Determine experimental variables including the percentage of waste tyre rubber to be incorporated into concrete mix.

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Develop concrete mixture with varying proportions of waste tyre rubber considering sustainability goals.

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Conduct Compressive testing of produced Concrete Paver blocks.

Materials

1. Natural aggregate

Gravels are obtained by crushing natural basalt stone sourced from quarries in close proximity to Pune. They possess characteristics such as hardness, strength, toughness, clarity, and freedom from veins, alkali, vegetable matter, and other harmful substances. The aggregates used in the construction are carefully selected to ensure they do not contain any materials that could compromise the strength or durability of the concrete.For fine aggregate, natural river sand with a maximum particle size of 4.75 mm was utilized. Coarse aggregate consisted of crushed stone with a maximum particle size of 20 mm. The crushed stone was subjected to testing in accordance with the specifications outlined in the Indian Standard IS: 383 (1970). The physical properties of the aggregate were evaluated following the guidelines provided in IS: 2386 (1963).

Figure No. 01 Natural Aggregate

2. Sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is formed through the erosion and weathering of rocks, such as quartz, limestone, granite, and basalt, over long periods of time. The size of sand particles typically ranges from 0.0625 mm to 2 mm in diameter, falling between the coarser gravel and the finer silt. Sand is commonly found in various environments, including beaches, deserts, riverbeds, and dunes.Its composition and color can vary depending on its source. Silica, in the form of quartz, isthe most common mineral found in sand, although other minerals like feldspar, mica, andshell fragments may also be present.Due to its physical properties, sand is widely used in construction, civil engineering, landscaping, and other applications. It serves as a key component in concrete and mortar mixtures, providing strength and stability. Sand is also used as a bedding material for laying bricks or pavers, as a filtration medium in water treatment processes, and as a base material for sports fields and playgrounds. Its ability to retain water and allow for drainage makes it a versatile material in various industries.

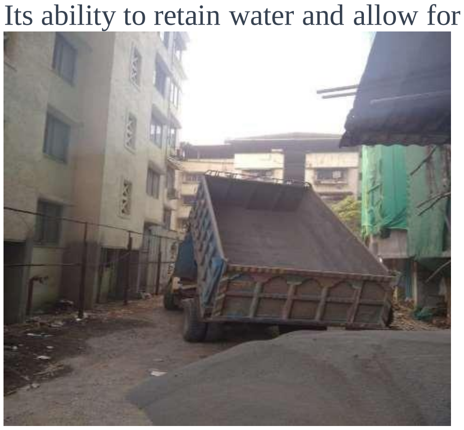

Figure No. 02 Sand

3. Cement

Cement is a fine powder made from a combination of minerals, primarily limestone, clay, and other materials, that are heated to a high temperature and then ground into a fine powder. It is one of the key ingredients in concrete, along with water and aggregates (such as sand, gravel,or crushed stone).Cement acts as a binding agent in concrete, providing strength and durability to the final product. When mixed with water, cement undergoes a chemical reaction called hydration, where it forms a paste that hardens over time and binds the aggregates together, creating a solid and strong material.

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Figure No. 03 Cement

4. Scrap Rubber

Waste tyre rubber is commonly used as a fuel in various industries, including thermal power plants, cement kilns, and brick kilns. In addition to its use as fuel, scrap tyre rubber cubes have been employed as a coarse aggregate substitute in construction materials. The tyres usedfor this purpose are typically truck and tractor tyres, which have different constituent materials and properties compared to other types of tyres. Rubber aggregates derived from discarded tyre rubber, ranging in sizes of 20-10 mm and 10-5 mm, are utilized as replacements for natural aggregates in cement concrete. The percentage of rubber mixed in the concrete varies at 0%,5%, 10%, 15%, and 20% of the normal aggregates. The replacement is done on a volume basis, wherethe natural aggregates are replaced by rubber aggregates.

Figure No. 04 Scrap Rubber

5. Potable Water

Water used for drinking purpose is used for mixing and curing. Water used inconcrete is free from sewage, oil, acids, strong alkalies or vegetable matter, clay &

Testing of Cube

Test for Compressive Strength on Concrete Cube Specimen (IS: 516)-1959

1. Specimen stored in water and tested immediately on removal from the water,while they are in the wet condition.
2. Surface water and grit is then wiped off the specimens and any projecting fins

removed.

3. The weight of specimen noted before testing.
4. The bearing surfaces of the testing machine wiped clean and loose sand or other material removed from the surface of the specimen, which are to be in contact with the compression platens The cube specimen placed in the machine in such a manner that the load applied to opposite sides of the cube as cast.
5. The axis of the specimen carefully aligned with the center of thrust of the spherically seated platen.
6. As the spherically seated block is brought to bear on the specimen, the movable portion rotated gently by hand so uniform seating may be obtained.
7. The load applied without shock and increased continuously until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained.
8. The maximum load applied to the specimen then recorded and the appearance of the concrete and any usual features in the type of failure recorded.

EXPERIMENTAL STUDY

Testing of Specimen

Figure No.5 Testing of Specimen

Results

Table For Compressive Strength of concrete cube.

Specimen No	Age of specimen	Area of Specimen (sqm)	MaximumLoad (KN)	Average compressive Strength. (N/mm2)
01	03	22.5	190	8.63
02	03	22.5	198	
03	03	22.5	196	
04	07	22.5	340	15.31
05	07	22.5	350	
06	07	22.5	344	
07	28	22.5	580	25.47
08	28	22.5	568	
09	28	22.5	572	

Conclusions

1. Improved Sustainability: The use of waste tyre rubber as a replacement forconventional aggregates in concrete paver blocks contributes to the sustainable utilization of resources. It helps in reducing the environmental impact associated with waste tyre disposal and promotes the recycling and reuse of materials.
2. Enhanced Mechanical Properties: The addition of waste tyre rubber has the potential to improve the mechanical properties of concrete paver blocks. It can enhance properties such as flexibility, toughness, and impact resistance, making the blocksmore durable and suitable for various applications.
3. Reduced Environmental Impact: Incorporating waste tyre rubber in concrete paverblocks reduces the demand for natural resources, such as aggregates. This helps in preserving natural materials and mitigating the environmental impact caused by traditional extraction processes.

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